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Practical Poultry Management

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SIXTH EDITION

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Preface to the Sixth Edition

The practical and scientific knowledge of caring for poultry has seen marked changes over the years since *Practical Poultry Management* was published in 1925. Each succeeding edition has endeavored to bring to the reader these changes. The Sixth Edition is no exception.

A reorganization of chapters and material is presented, more in line with present-day handling of poultry. Nothing need interfere, however, with the reading or studying of subjects in any order desired.

Mass methods of keeping poultry and of brooding and rearing, which are rapidly coming to the front, emphasize that consideration of the early needs and training of the chick is as important to its future life as early home training is to our children today. The proper balance between chick instinct and management is vital in order to build strength for conquering later enemies or deficiencies.

Whatever the reason, new diseases gain in numbers and economic importance. Chronic respiratory disease and hemorrhagic disease, for example, travel faster than research. Their control may influence the severeness of other diseases or parasites. Certain drugs have replaced others formerly used, and antibiotics have entered the picture. Recent advances in the basic knowledge of the leucosis complex indicate that we may be dealing with four distinct disease entities caused by four different agents.

No less startling is what research continues to show concerning *built-up litter*, now changing, in relation to length of time in use, to the term *compost litter*. Though the use of compost litter is not yet universally approved, years of testing and practical work indicate its desirable possibilities. Many poultrymen find the practice hard to accept because it appears to violate principles of sanitation. But if floor conditions and waterers are in good and proper relationship,

compost litter can render a valuable service. Its success or failure appears to depend on the man using it.

The necessity for water, with its contribution to filth and parasites, demands more thought and action with regard to equipment installations. Proper ventilation is necessary, but is not always the cause of wet litter. Dryness around water dishes and over the entire floor is important in parasite control. This is seldom realized, and because dryness is difficult and expensive to accomplish, its importance is often depreciated.

Included in the text are energy values of feeds, the latest National Research Council nutrient requirements, and practical levels of nutrients for use in formulating rations, with patterns and examples of present-day practice and methods of calculating the final composition of rations.

In this edition, the chapters on selecting and mating breeders (including work on head and body type, defects, and the four systems of breeding poultry) have been reduced, and the chapter on poultry shows has been deleted. The description of caponizing is now presented mostly in pictures, as is that for head type and for the methods of incubating eggs practiced today and thousands of years ago in Egypt.

Among new additions to the text is a discussion of birds which appear and act like layers but do not lay, called "exceptions" in these pages. Other new material includes sanitizing eggs, dimensions of the new wood and fiber egg cases, the most recent standards for quality of eggs and for egg grades, the preparation of "ready-to-cook" poultry, standards for quality of poultry, wrapping for freezing, barbecuing, and hormonizing.

Many illustrations have been replaced by new ones that tell better today's story of practical poultry management. I am responsible for most of these.

I desire to thank all who helped in any way in the development of this book—especially my wife, who again helped with encouragement, patience, and the tedious reading and checking of proof, and Mrs. Florence Krejca, who typed the manuscript; and the following who read and discussed material in their respective fields: Dr. Martin Sevoian, poultry diseases; Dr. R. K. Cole, lymphomatosis, breeding, and "exceptions"; Dr. G. F. Heuser, nutrition and feeding; Dr. F. W. Hill, whose material on nutrition was freely used; Dr. J. H. Bruckner, for his counsel and aid; Dr. G. O. Hall, breeding methods;

Dr. A. L. Romanoff, embryology; and Professor R. C. Baker, eggs and poultry.

It is impossible to list all who aided by providing material. Credit has been given in all cases. The references list recent publications, and many appear as footnotes. The periodicals *Poultry Science* and *World's Poultry Science* have been frequently consulted.

H. E. BOTSFORD

Jacksonville, New York
July 1956

Preface to the First Edition

Poultry Husbandry is both a science and an art. As a science, it deals with the facts, principles, and natural laws underlying the successful management of poultry. Many of the scientific principles set forth in this book are comparatively new, although numerous practices based upon them have been followed for centuries with good results.

The art of Poultry Husbandry is the skill needed to put these principles into practice. One may imitate his neighbor's practice and thus unconsciously use scientific principles. In order to practice the true art of Poultry Husbandry, however, one must have a knowledge of these basic principles coupled with the skill to apply them successfully.

This book is prepared as a guide to vocational school pupils and poultrymen, whether they keep poultry on a commercial scale or in small flocks. The suggestions have been carefully tested through research and experience. The chapters are organized about the major activities in conducting the poultry enterprise. Where operative activity is involved, specific directions have been included for performing each job. Under the caption "General Information" or in separate chapters, explanations of principles and practices related to these activities have been included. For the most part, those activities dealing with managerial or local business decisions have been left for the development of individual teachers, to meet the needs of local groups of pupils and local enterprise and market practices. The community surveys at the close of many chapters, and particularly the study outlined on page 491, will serve as a guide to pupils and teachers in studying such managerial activities.

The essential key-factor in the successful management of a poultry enterprise is efficient stock. Because of the importance of this phase of the business, the operations of culling have been included

as Chapter I. In the remaining chapters an effort has been made to pursue a seasonal sequence of activities throughout the year. In this connection, however, it will be noted that many operations are conducted throughout all seasons.

The authors desire to express their appreciation to the following members of the Poultry Department at Cornell University who read and improved portions of the manuscript in their special subject-matter fields: Mr. R. C. Bradley, Sanitation; Mr. G. O. Hall, Breeds, Breeding and Culling; Dr. G. F. Heuser, Feeding; Mr. J. C. Huttar, Caponizing; Dr. L. C. Norris, Feeding; Dr. C. K. Powell, Marketing; and Professor L. E. Weaver, Incubation and Brooding; also to Mr. W. G. Krum, who read the entire manuscript, and Messrs. F. E. Andrews, L. M. Hurd, and R. C. Ogle, each of whom contributed in many ways to the book.

For reading chapters on Marketing, Diseases and Embryology respectively and giving valuable suggestions, the authors wish to thank Dr. E. W. Benjamin, Glen Ridge, New Jersey, Dr. E. L. Brunett, New York State Veterinary College, Cornell University, and Dr. B. F. Kingsbury, Medical College, Cornell University.

Grateful appreciation is tendered Mrs. Harold E. Botsford, who gave many days to the development of this book.

Chapter IX is almost entirely from Cornell Bulletin 90, by Professor F. L. Fairbanks, Department of Rural Engineering, Cornell University.

The great majority of the pictures were especially taken by the authors to illustrate the text, and a number are from the Poultry Department at Cornell University.

In several instances illustrations from books and experiment station bulletins and educational material from commercial firms have been used, for which the authors express their appreciation. Credit has been given in all cases.

THE AUTHORS AND EDITORS.

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CHAPTER

1

Brooding and Feeding Chickens

Brooding is one of the poultryman's most interesting types of work. The thrill of placing chicks under the brooders and watching them develop is well-nigh universal. But brooding has its serious side that must not be slighted, since results, desirable or not, have their effects later on the quality of pullets in the laying house.

The normal short life of the domestic fowl requires renewing 75 to 100 per cent of the laying flock each year. It is an expensive procedure ordinarily, but it is cheaper than buying pullets of the same age. Furthermore, it is more fun.

To do the job well, one should possess: (1) the right kind of chicks, (2) a knowledge of what chicks need generally and their reactions to good or poor conditions, (3) the ability to make necessary changes in temperature, ventilation, feeding, watering, litter conditions, and the numerous other *management* practices.

Much will be learned by working with chicks. The brooder attendant who can tell by the chicks' "chirp" language and their actions whether they are comfortable or what their trouble may be, is well on the way to success. To such as this, brooding chicks is a joy, and whether small or large flocks are involved, the end result is likely to be satisfactory to both chicks and attendant.

Purchasing baby chicks is the modern way used by many poultry keepers for renewing their flocks. Chicks of the quality and breeding desired may be available from local breeders or hatcherymen or, because of excellent transportation facilities, from distant sources.

Not all chicks are purchased; some will be hatched at home. But regardless of their source, if they are to be brooded artificially rather than naturally, the important jobs should be checked in an order somewhat the same as that of the following discussion.

Operations:

1. Preparing the brooder house and heater.
2. Operating the brooder.
3. Checking the temperature.
4. Receiving the chicks.
5. Managing the chicks.
6. Letting the chicks outdoors.
7. Providing protection.
8. Brooding and rearing in confinement.
9. Brooding with the hen.

General information:

1. Principles of brooding.
2. Choosing the type of brooder house.
3. Selecting the heater.
4. Brooder house construction and range shelters.

Operations**1. Preparing the brooder house and heater**

If a portable brooder house is used, raise the house about a foot above the ground. Boards should be placed on all sides to prevent the chicks from running under the house during the first 2 or 3 weeks. After that, the boards may be removed. The chicks should then be old enough to find their way back into the brooder, and the raised building provides a place beneath which the chicks may run for shelter or for shade during warm weather.

See that the floor is tight. If there are cracks between the boards it will be advisable to cover them with a nonburning roofing paper and lay boards on the paper to hold it in place and provide extra warmth, especially beneath the hover.

Regardless of the kind of brooder house used, the general rule for many years has been to be sure it is thoroughly cleaned before the chicks are placed in it. Scrape all sediment from the floor and sweep the floor and walls clean. A good extra precaution is to scrub the floor, using a stiff broom and scalding hot water into which lye has been placed at the rate of 1 ounce to 12 quarts of water. After the house is dry, disinfect well. As a precaution against mites, lice, etc., paint wooden floors with Carbolineum, and walls to a height of 1½ feet. Do this a month before the chicks go in.

Next, overhaul the brooder, making certain that all parts are

present and workable. Do this several days in advance; never leave it until the chicks are ready for the brooder. Broken parts may cause several days' delay.

Set up the brooder, taking care that all parts are properly adjusted, that the pipe extends through the roof to a total distance of 10 feet or more from the brooder if coal or oil brooders are used,

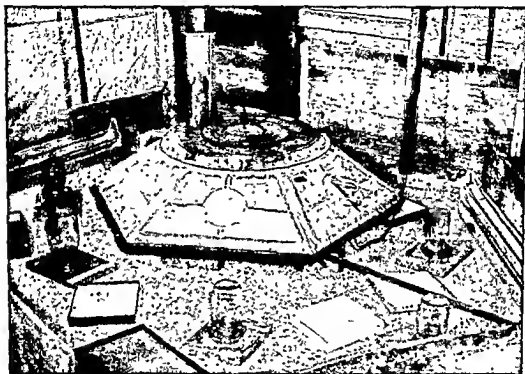
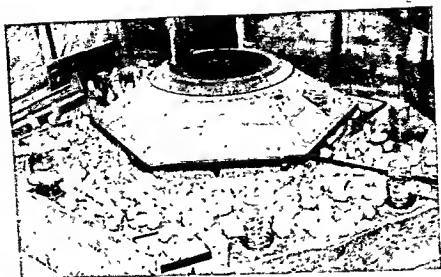


FIG. 1. An oil brooder with temporary feeders and waterers ready for 300 to 500 chicks. Ample room is available to give 1 sq. ft. of floor space per chick later.

and that the roof cannot leak. Cover the floor near the heater with 1 to 2 inches or more of litter which is free from all mustiness. Some advise 3 to 5 inches. Shavings, clover, alfalfa, or clean straw, cut into 1-inch lengths, may be scattered over the entire floor. Hayseed or chaff is not desirable.

Ten-inch guards of boards, roofing paper, or special paper should be placed around the heater, within 18 inches to 3 feet of it, with a strip of roofing paper or a bank of straw in each corner of the house, if necessary, to make it round. If it is left square, the chicks may crowd into the corners later and smother.

Provide 2 shallow wooden trays or box lids to each 50 chicks for feed and a 1- or 2-quart jar water fountain to each 75 to 100



A



B

FIG. 2 The brooder is the seat of warmth and protection for several weeks. *A.* The first day in the brooder. Note the several quart waterers and box-lid feeders well distributed. Larger waterers ($1\frac{1}{2}$ or 5 gal.) may be used, but smaller and more numerous ones are better for the first few days. *B.* The same chicks on the third day. Note the enlarged pen, long wooden feeders with sides 2" high, and the gradual concentration of small waterers. Bodies are growing rapidly, keeping pace with the large wing feathers, indicating healthy active development.

chicks. (Figs. 1, 3.) Numbers and sizes may be changed. Whenever a chick is, it should be not far from food or water, thus avoiding dehydration and loss of weight. Place in the pen, to acquaint the chicks with it, one or more "reel" wooden or metal feeders with 2-inch sides.

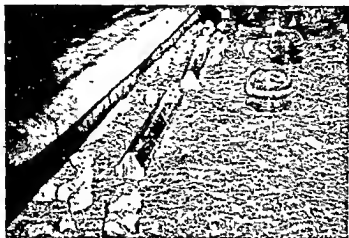


FIG. 3. Section in a long permanent brooder. Hot-water pipes are covered with heavy paper to conserve heat. Note large glass waterers.

A 10- or 15-watt light in the room for each 250 chicks is an advantage. Use at night during the first few weeks of brooding.

2. Operating the brooder

For both oil and coal brooders, regular attention is necessary night and morning. Check the oil supply and flame condition in the oil brooder at least twice daily and the carbon accumulation each day. Electric or gas brooders may need the least attention. Shake the coal stove at night and in the morning until live coals are seen at the grate. Then fill to the top with hard coal. Either pea or chestnut coal may be used, the latter being preferred. Remove ashes twice daily in cold weather. In certain models, the hover is arranged to be lifted. It is not necessary nor desirable to raise the hover during the first 2 or 3 weeks. Should the temperature under it become too high, adjust the regulator.

In very warm weather, it is desirable to raise the hover during the day in order to keep the fire from going out. This lets the heat escape and causes the regulator to allow sufficient draft to keep the fire burning.

When first starting the stove, watch the thermostat and, by means of the thermometer, regulate it so that the dampers will

operate at approximately the correct temperature. Avoid too high a temperature, since this may destroy the thermostat, especially if it is of the wafer type. Once it is operating correctly, it may be regulated to suit the chicks by slightly turning the adjustment nut.

3. Checking the temperature

Start the brooder and run it for 1 or 2 days before the chicks are put in the house. This precaution may avoid injury to valuable chicks.



FIG. 4. Chicks one to two weeks old, illustrating their knowledge of the location of warmth, food, and water and how they meet their various needs.

The temperature at which to run the stove will vary with the season and the brooder. The chicks should be comfortable. If too warm or too cold, they will not develop properly. In general, the temperature at the outer edge of the hover and about 2 inches above the floor should be approximately 90 degrees F. As the chicks grow, this temperature may be decreased 5 degrees per week until artificial heat is entirely discarded.

The best thermometer is a healthy chick. When comfortable, the chicks, early in the evening, are spread out around the edge of the hover, some alone and others together in little groups.

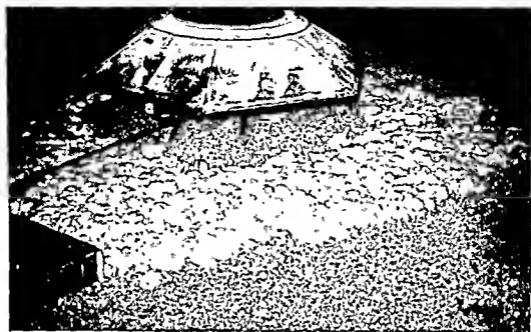


FIG. 5. Chick comfort at night. Same chicks as in Fig. 4.

Their heads are often lying on the litter and their wings spread out. This attitude in sleep denotes "chick comfort." If the chicks are huddled together or are all under the hover, more heat is desirable.

4. Receiving the chicks

Chicks received by express or mail will be taken directly to the brooder in their shipping boxes. Remove the chicks by hand, count, and place carefully near the hover. They should start at once to eat and drink.

Opening the brooder house doors admits cold air which may affect the thermostat and, hence, the temperature. Close the brooder house doors quickly. The temperature should adjust itself, but let the chicks move freely away if it is too high, to avoid overheating them.

5. Managing the chicks

Food and water should be in place when the chicks arrive at the brooder. See page 13, "Train the chicks."

First 2 days. Keep the chicks within 2 to 3 feet of the brooder. Feed chick starter mash * in box lids or shallow trays (one or two handfuls several times daily) and in reel feeders filled to the top of the 2-inch sides. Keep the water dishes supplied with fresh water. (See A of Fig. 2.)



FIG. 6. Homemade chick feeder. It may be made 4" or 5" wide with removable side boards, each 2" wide, and adjustable lath reel. Chicks will feed the first day from the feeder level full of mash and sides 2" high. As they grow, less mash is put in to avoid wasting. At 1½ to 2 weeks, the other 2" side is attached, and the reel is raised to permit head space between the edges of reel and feeder sides.



FIG. 7. Chick feeder 4" wide using a 2×2 for a reel resting on nails that fit into holes bored on a slant. The height of the reel above the mash can be adjusted by relocating the nails.

Third and fourth days. Let the chicks go 6 to 8 feet away from the hover. Place one 4-foot feeder, preferably with a reel and 2-inch sides, for each 100 chicks, feeding from both sides. Leave

* A common practice is to feed "chick grain" the first 2 days to decrease pastiness. This may be more tradition than necessity; research shows no increased mortality directly traceable to pastiness. Many believe that the more rapid growth obtained by feeding mash at this stage outweighs the possible danger of increased pastiness.

the original trays, removing one or two each day until all are out. (See *B* of Fig. 2.)

Two 5-gallon waterers are needed for 400-500 chicks. If this type of waterer is to be used throughout the brooding period, place one of them on a wire-top frame with 3- to 4-inch sides, the other

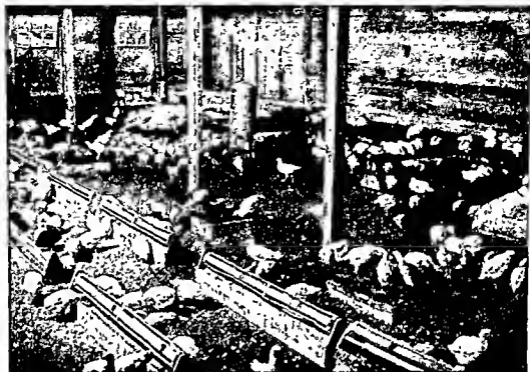


FIG. 8. In this 25' \times 40' pen of 1000 pullets, plus a few crossbred capons, 5 automatic waterers were started at about 1 week of age. The five 5-gal. fountains were removed as the chicks learned to drink. Spillage water was confined and shoveled out when necessary. Home-made nonwaste feeders reduce feed cost.

on the floor nearby. If automatic waterers are to be used later, place both fountains on 1- or 2-inch blocks of wood on the floor. Remove one small water jar each day until all are gone. (See Fig. 4.)

Fifth day and later. Remove the guards and allow the chicks the entire pen or room. If automatic waterers are used, one to 150-200 chicks, start them, but use the 5-gallon fountains until the chicks have found them. Loosen the litter on the floor with a rake or fork. Repeat each day for several weeks.

At 1½ weeks put in an additional 4-foot feeder (feed from both sides) for each 200 chicks. Put a 2-inch strip on both sides (Fig. 8).

All feeders should now be 4 inches deep. Fill them level with starter mash at the start so that the chicks can reach it, but reduce the amount of mash as the chicks grow, to prevent "billing out" and wasting.

Put in a few perches.

Start feeding intermediate grain at 5 weeks in separate feeders. Give small granite grit in separate feeders. Change to coarse cracked corn, wheat, and oats at 6 to 8 weeks.



FIG. 9. At 7-8 weeks, small feeders are replaced by larger feeders, which will be used through the remaining life of the birds. Feeder box is 5' X 8" X 8".

There are two on each stand, grain in one and mash in the other.

At 8 weeks, change to feeders 5 to 6 feet long with sides 8 inches high and 8 inches wide, with reel on the top (Fig. 9). These may be used from 8 weeks throughout life. To prevent waste, fill only to within 2 inches of the top with mash. See Fig. 18. *Change from starter to growing mash at 8 weeks.*

The grain feeders may be filled nearly full, as very little will be wasted. As the pullets reach laying age and are in the laying house, at least two 5- or 6-foot feeders, dimensions as above, double-deck, for each 100 layers are needed (Figs. 9 and 79). Grain may be fed in the lower, if trough feeding, and mash in the upper troughs.

Seventh and eighth weeks. Provide more room or move the pullets to the range. Provide four range shelters or colony houses per acre, placed 100 feet apart, and put 100 to 125 pullets in each shelter.

Change to whole corn, wheat, and oats between 9 and 11 weeks. Give granite or calcite grit.

See Chapter 3 for further information concerning rearing.

6. Letting the chicks outdoors

Admit direct sunlight through a large door or other openings whenever the day is sunny and wind is not blowing in. Restricted outdoor range on the ground should be used with caution with large flocks. Large numbers of chicks on limited range quickly create a filthy soil.

Smaller flocks in *portable house brooding* should be allowed outside and the houses moved 25 to 30 feet, if need be, to prevent soil contamination. Chicks in small houses need to escape from an excessively warm room. If a yard is necessary, enlarge the outside yard occasionally as the chicks grow.

If *clean ground* is not available, let chicks out on platforms of $\frac{3}{4}$ -inch mesh wire, suspended 1 foot above the ground, or on a concrete platform.

7. Providing protection

The life of young chickens is beset with many dangers. Time and money will be saved if the poultryman anticipates the chick hazards and takes proper precautions to prevent them. These hazards are many and difficult to overcome completely. An experienced poultryman will have no difficulty in recalling at least a score of preventable ways in which he has lost chickens.

Among the dangers to be overcome are losses from the depredations of dogs, cats, rats, weasels, skunks, foxes, coons, crows, hawks, owls; losses due to chicks falling in holes, barrels, and pails, getting caught in wire, chilled in the rain; overheated in the sun, destroyed by fire, stepped on by farm animals and humans; poisoning caused by drinking sour milk from galvanized dishes, by eating poison intended for their enemies, or by having access to old paint cans; smothering; and stealing by chicken thieves.

The brooding season therefore should be preceded by a clean-up campaign to destroy natural enemies and to prevent accidental losses, or the chicks should be reared in confinement.

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8. Brooding and rearing in confinement

The floor method. Chicks may be brooded inside until 8 to 12 weeks old, with or without an outside wire run, or in permanent brooders, or in laying houses which they will eventually occupy as layers. Escape from the intense heat of the brooder stove and of the sun must be provided. Pullets reared to laying age in confinement, with ample floor space, feed, and water, develop well. Much depends on the attention given to their needs by the attendant, since the pullets are entirely at his mercy. Disease and pest control must not be neglected.

Overcrowding must be avoided. The approximate amount of floor space to provide for each pullet varies with the size of the bird. The following may serve as a guide:

	Light Breeds, sq. ft.	Heavy Breeds, sq. ft.
3 to 8 weeks	1	1
8 to 12 weeks	1½	2
12 to 16 weeks	2	3
16 weeks on	3	4

9. Brooding with the hen

Natural brooding offers a relief from many of the trials of artificial brooding, and may be used where only a few chicks are reared. If a large number are brooded, the cost of equipment and labor is considerable and the artificial method is to be preferred.

Select the hen for brooding. Where several hens are set at the same time, the chicks should be given to those hens which appear to be the best mothers, and the other hens broken up or reset. Usually, the American varieties, Rocks, Reds, New Hampshires, or crossbreds, are the best mothers. The Mediterranean varieties are not dependable, and the Asiatics are too clumsy.

Number of chicks per hen. In very early spring, 12 to 15 chicks to each hen are sufficient. Later, 18 to 25 chicks may be given. The number will depend somewhat on the size of the hen and chicks.

Hens will not always accept chicks which they themselves have not hatched, particularly if they are of a different color. It is well, therefore, to place any extra chicks under the hen at night if they are not of the same appearance; otherwise they may be given to her when hen and chicks are transferred to the coop.

Select a brood coop. The brood coop should be roomy and well ventilated. It may be built on skids or set on blocks of wood, stones, or bricks, to avoid the danger of having a damp floor. Build the coop $2\frac{1}{2}$ or 3 feet square and about as high. The front may be wired or slatted, but should never be solid or of glass. A hood may be built on the front to protect it from sun or rain, but an opening should be provided above the hood and also at the rear, near the roof, for ventilation. The roof may be *shed* or *gable* type.

Range and shade for comfort and safety. It is usually better to keep the hen confined during the forenoon until the chicks are several weeks old. This prevents their being led through wet grass and ensures plenty of feed.

If necessary to confine them, the yard may be made of high boards at first and later of slats or wire. Shade should be provided.

Destroy the lice and mites in advance. Treat the hen with sodium fluoride before the chicks are given to her. Watch for lice, and repeat the treatment when needed. Spray the coop several weeks before using with a mite repellent, such as a coal-tar disinfectant, or paint with Carbolineum. If this painting has to be done within 2 weeks before chicks use the brood coop, wash out with cold water after it is painted.

General Information

1. Principles of brooding

It is desirable to observe all the following rules in brooding.

Train the chicks, which are guided by instinct. These instincts are to eat, to drink, to be warm, but not too warm, and to find the means of satisfying these desires. Chicks learn very quickly. They are able to discriminate between litter and feed, between hot and cold, and to do something about all of their needs if the means are there. The instinct for self-preservation is highly developed. It should be borne in mind that chicks are very young; at their age they cannot know very much, they have no regard for the niceties of life as we think of them, and they are apparently just as happy in filth as in cleanliness. They know nothing about the dangers that may lurk in filthy surroundings, nor of the danger to themselves or their brethren from crowding.

Compare the chick to ourselves at similar stages in life. We,

as babes, possess the instinct to eat, sleep, and cry, and we learn fast how to get satisfaction. During our rearing, except in rare instances, we behave much like chicks of a comparable period. Chicks, however, can walk and are therefore quite able to take care of themselves, provided their human attendants have done their part intelligently.

How can we use the chick's instincts to accomplish what is best for both the chick and the poultryman? Chicks grow rapidly, and their needs change quickly. Using these facts, the poultryman charts his course. See page 7, "Managing the chicks."

Maintain a proper temperature. The brooder should be sufficiently heated to prevent the chicks from crowding to keep warm, but not so warm that they push away. Season of year and location may affect this. Brooder temperatures may vary from 88 to 95 degrees F. for the first few days (see page 6).

Provide pure air without drafts. The chick is a fast-growing, rapid-breathing animal, requiring rapid digestive and assimilative changes, and therefore suffers seriously when closely confined and compelled to breathe impure air. Pure air is the cheapest and certainly one of the best means of producing vigorous stock. A constant change of air, without dangerous drafts, within the brooder compartment is necessary.

Give the chicks a wide choice of temperatures, because after the first few days a continuous high temperature saps the vitality. Fear of chilling the chicks often results in keeping the room and the chicks dangerously warm. Cool fresh air is invigorating and healthful, and the chicks enjoy it if they can quickly get back to the warmth. The brooder house or room should be large enough to allow the chicks to find a temperature several degrees cooler than that under the hover, or the chicks should be let outdoors.

Maintain proper ventilation. Ventilation means moving enough air in the proper direction to take out excess moisture (except water spillage) and provide chick comfort. It involves moving air both into and out of the brooder house.

Intakes. Air is normally supplied through windows which slide up, down, or sideways, or tip in. Specially constructed intakes may open near the ceiling. Air may also move in under the window, up and over a board nailed from stud to stud inside the house, flush with the sill and at the bottom of the window, which is raised 1 or 2 inches. This leaves a space for air to enter between the board and the window.

Outlet. Portable brooder houses with upward sloping roofs, or small rooms with flat ceilings used for brooding, may have the outlet at the front, near the ceiling (see page 86). Only occasional adjustment of the windows is ordinarily required. The time of year and the actions of the chicks will govern the amount of opening.

Chicks should distribute themselves fairly evenly at feeders and waterers. When a feeder or a waterer is consistently ignored by the chicks, the attendant should determine if the air is moving too fast in that area. Inactive chicks and air that is stagnant and too warm may be a sign that the air is not moving fast enough. Slight adjustment of the windows may be all that is needed. As chicks grow, more ventilation is required.

Permanent brooder houses are ventilated as has just been described, or by flues or electric fans (page 20). Ventilator fans are increasing in popularity. See page 92 for sizes and page 91 for intake space. Intakes are required on various walls to provide sufficient intake space. Although several methods of ventilating are in use, the principles outlined here generally apply.

Use an adequate ration. Prepared chick rations today contain vitamin D, which has replaced the need for direct sunshine. This offers a choice between the use of range land and confinement brooding.

2. Choosing the type of brooder house

Four types generally prevail: small outdoor or indoor types, battery or cage types, portable or colony brooders, and the permanently located brooder building.

The small brooder. Typical of those in which all care is done from the outside are the "sunshine" brooders, about 3×4 feet, used in Southern California (Figs. 10 and 11). They hold about 100 chicks, and may be single or in multiple units. If the latter, a roof is often placed over them (Fig. 12). Each has a separate outside wire-enclosed run. Both brooder and run are elevated above the ground. Electricity is the heat medium for single units, and long hot-water pipes for multiple units. In areas where severe weather is less of a problem than in many parts of the country, such structures are found on ranches comprising several thousand layers. The temperature regulation and watering are automatic, while feeding may require more labor than in long permanent brooder houses.

In colder climates, indoor or outdoor small lamp-heated brooder

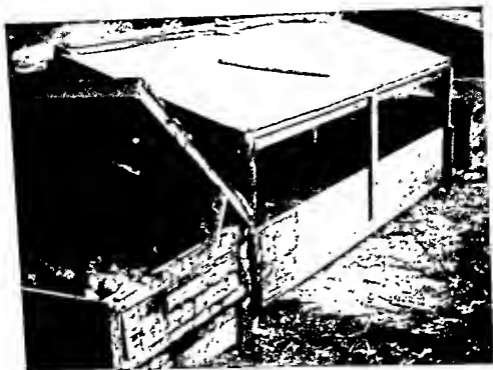


FIG. 10. An electric "sunshine" brooder in California, with outdoor run.



FIG. 11. Sunshine brooders in California.

shelters holding 50 to 150 chicks require considerable attention in proportion to the number of chicks brooded, and none of them can be recommended where 200 or more chicks are to be brooded.

Battery brooders consist of several units of chicks, and require housing. The use of batteries for brooding chicks is an attempt to decrease labor by reducing travel. Space is economized by confining chickens in compartments several tiers high. The more completely the battery provides the essential features of natural



FIG. 12. Sunshine brooders built in long rows where driving rain is seldom a problem.

brooding, the more successful it is. These essentials are (a) access at all times to a comfortable temperature, without wide extremes and with opportunity for a choice of heat; (b) abundance of space for feeding and watering in proportion to the floor area; (c) ease of cleaning and disinfecting; (d) portable parts; (e) economy of fuel; (f) convenience in handling chicks in and out of the brooder; (g) suitable control of heat, ventilation, humidity, and sunlight.

Under even the most favorable circumstances, conditions are distinctly artificial and require skillful handling in order to secure satisfactory results. The field of usefulness of battery brooders is exceedingly limited. Their chief value is as a short-time nursery for holding chicks not more than 1 to 3 weeks at most, except for broiler purposes.

The sooner properly developed battery chicks destined for layers can be placed on the floor near a boiler, the better it will be for the chicks. Within a day or two they should be allowed the freedom of the house, and within a week or so they should be handled the same as floor-brooded chicks.

The chief objections to battery brooding are the indoor inactive life of the chicks, owing to their close confinement, and the danger of crowding as the result of rapid growth. For future layers or broilers in large numbers, the battery has little value except as temporary housing for surplus chicks. It adds extra expense if the floor method is to be used after a few weeks. An all-battery laying plant is more adaptable to the Pacific Coast states than to the colder climates, since there the battery brooder pens require only a roof.

Batteries are often used for the continuous production of pullets to replace layers removed by death or culling. Because it is necessary to keep the cages filled, since profits are reckoned on a "per cage" basis, the danger of carrying respiratory diseases is ever-present and must be carefully guarded against.

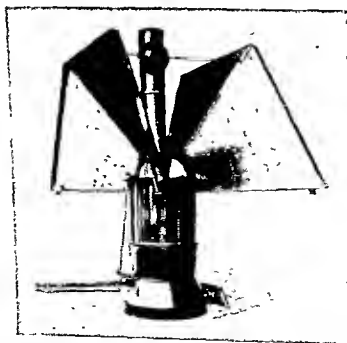


FIG 13 A coal brooder Note direct and check draft operated by the thermostat; also, draft regulator in the chimney. Courtesy Jamesway Manufacturing Co

The portable brooder house replaced the permanent brooder house years ago because exposure to direct sunlight and change of range gave better results. Labor cost for brooding is high, and size of flock is necessarily small. Warm-weather brooding is difficult, and crowding may occur in cold weather. Coal, oil, gas, wood, or electricity furnishes the heat (Figs. 13 and 14). From 250 to 300 chicks under one hover is customary at the start. If range is available soon after, this type of brooder provides desirable conditions.

The portable brooder house is still widely used. On the range, the house may serve as a shelter. Sizes exceeding 10×12 feet are not common.

Permanently located brooder houses provide conditions easier for the operator throughout the northern United States when the weather is unsettled and cold, or for brooding to 8 or 10 weeks of age. This brooder was unsuccessfully used years ago, before vitamins were known and when the control of chick diseases was in its infancy. The portable brooder house replaced it. As practical knowledge of nutrition, disease, breeding, and the needs of chicks has grown, permanent brooder houses are rapidly replacing portable houses.

Long and wide brooder houses equipped with heat, either above or under the floor, have many advantages over portable brooder houses. They reduce labor and fuel costs, provide better conditions for the chicks as they gain size, and fit in better with most management plans for the plant as a whole. Whether the management plan calls for confinement or range rearing, the permanent type of house may be used as hen barracks (page 140) or for growing broilers for market.

Permanent brooder houses may be equipped with a series of individual brooders or with a central heating system using continuous hot-water or hot-air pipes. Warm-air blower systems are meeting with success. For central systems, heat may be provided by natural gas, bottled gas, coal, or oil.

Large pens, 25 feet square with one brooder stove, will ac-

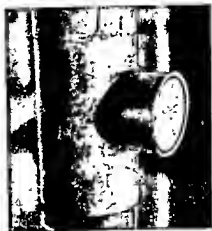


FIG. 14. A draft regulator in the brooder chimney.



FIG. 18. In permanent brooder house, small feeders give way to large ones at 7 to 8 weeks and may be hung against the wall, out of the way. Note reels at left behind straps stretched between studs.

ers when considerable heat is needed, as where late fall, winter, or early spring brooding is practiced.

Hard coal burning brooders were the standard for many years in colder sections of the country and, even though coal has to be supplied and ashes removed, are popular. Some who have deserted them for other types have returned to them. Direct and check drafts on the stove, operating on a single thermostat, and an automatic draft equalizer in the pipe are desirable in any type of fuel-burning stove (Figs. 13 and 14).

Oil heaters of the better types are safe, accurate, and easy to operate. Oil-burning types, thermostatically controlled, generate considerable warmth in cool weather, and in warm weather they reduce the heat automatically, thus keeping the temperature within the room well regulated.

Desirable features of heaters that burn oil direct, rather than through a wick, are provision to catch surplus oil and pipe it away from the fire, thermostat control of the oil feed, and convenient arrangements for cleaning carbon from the heater. Such heaters are quite safe and may be used satisfactorily in portable brooders or in large rooms.

Bottled gas brooders are proving popular because they are easily controlled and dependable. Little heat is given out into the room, however, and dampness may gather at the edge of the hover.

Electric brooders are popular for mild-weather brooding, and in colder climates when several brooders are used with auxiliary heat in a large room. As with gas-burning heaters, troublesome damp-

ness may occur near the edge of the hover, and unless auxiliary heat in the room is available in cold weather or water pipes

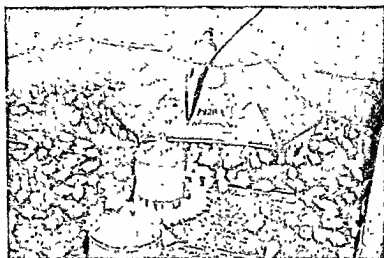


FIG. 19. A gas brooder.

are protected by heating cable, the water system may freeze. Interruption of electric power will mean certain disaster. Where auxiliary heat is necessary, it may well be supplied by a coal brooder. Heat directly under the electric brooder is sufficient, but the rapidly growing chicks should not encounter extreme cold when they move out into the room or when, later, they reach roosting age.

An essential consideration in deciding for or against electric brooders is the cost of operation per kilowatt hour. Costs under 3 cents per kilowatt hour are likely to compare favorably with those of other means of heating.

Desirable features for electric brooders are a well-insulated hover, fan ventilation, and a black-heat element. The brooder should be set on a platform of boards or planks at least 1 inch thick.

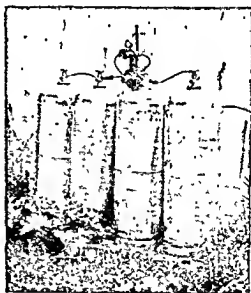


FIG. 20. Tanks holding the fuel supply for a gas brooder.

commodate 500 to 600 chicks, or 25×40 feet, 1000 chicks, until 8 weeks of age. Then they should be moved to the range shelters, or given more room with outdoor elevated wire runs, or more house room. The size of the house and its management will be governed.



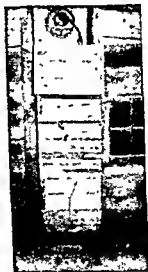
A



B



C



D

FIG. 15. A. Small permanent brooder house. B. The same, showing brooder pipes extending above the roof. C. Ventilator fan with small roof protector. D. The fan inside at top of flue draws air out. Note slide at bottom and hinged door (open) at top for use as needed.

by the number of chicks to be brooded. Houses brooding 19,000 to 40,000 chicks are in use.

Underfloor heat consists of laying heating pipes in the concrete floor. The warmth passes into the room, and all parts of the floor are of a similar temperature. Hovers are not needed; the chicks are warm wherever they are. The reasons for crowding are reduced. Used in permanent brooders, this type of heating may

offer possibilities, and the results will need to be watched and studied. Installation expense is considerable. Extra equipment

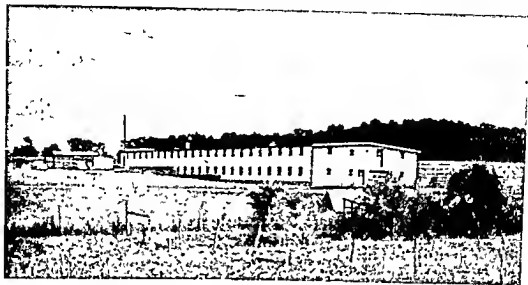


FIG. 16 A permanent brooder on a large poultry farm.

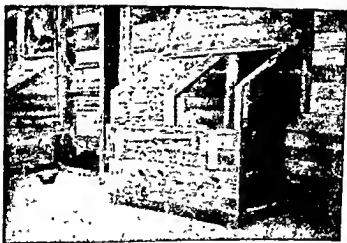


FIG. 17. Feed bins in a permanent brooder Front and top are hinged.

may be necessary to help adjust the room temperatures to sudden changes, provision may be needed to give the chicks a range of temperature, and excessive dehydration must be guarded against.

3. Selecting the heater

The choice of a heater is a decision normally between coal, oil, gas, electricity, and wood. Small indoor or outdoor houses are heated with kerosene lamps, electric bulbs, or electric units. Portable houses are usually equipped with coal, oil, gas, or wood brood-

4. Brooder house construction and range shelters

Write your state agricultural college for plans and bulletin material for brooders, range shelters, feeders for brooder and range use, and watering arrangements.

Community Survey

1. What percentage of the farmers in your community brood chicks by the portable brooder system? By the permanent brooder system?
2. Are houses or range shelters used for rearing?
3. What percentage use coal stoves? Oil stoves? Electric brooders? Underfloor heat? Gas? Which is preferred?
4. How many brood 300 or fewer under one stove?
5. How many brood more than 300 under one stove?
6. Are chicks given outdoor range during the brooding period?
7. How do the poultrymen tell whether the temperature of the brooder is correct?
8. Is confinement rearing practiced? Inside or on wire floors?
9. How closely do the square feet per chick conform to those on page 12.
10. Outline the ration, feeding practice, and rearing method for chicks used by a successful local poultry keeper.
11. At what age are chicks allowed to go outdoors?
12. Do the time of year and outside temperature influence this? How?

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Preventing and Treating Chick Diseases, Parasites, and Vices

Little chicks, like little children, are subject to diseases and other troubles peculiar to their age. Because of the rapidity with which chicks grow, their serious troubles are concentrated over a few weeks, instead of several years as with children. Happy is he who handles chicks in such a way that these troubles are avoided, or who, after the flock is attacked, knows how to diagnose the symptoms and where to go immediately to find and correct the cause of the disorder. It is always best to go immediately to the cause of trouble and remedy it, at the same time giving treatment. The best way, of course, is to handle the flock so that troubles do not occur.

A chick, because it is a small thing, is subject to many disadvantages in life, and for the first several weeks its life is in constant danger. Troubles may arise owing to defects in the breeding stock, errors in the management of it, faulty incubation or brooding, or the many respiratory disorders. Careful attention should be given each season to these possible sources of danger.

"An ounce of prevention is worth a pound of cure." After the chicks are hatched, many of the ordinary troubles may be prevented if care is given to the points mentioned in Chapter 1.

General Information

Diagnosing and treating chick troubles

When we call a doctor and he comes into the patient's room, the first thing he does is to find out what is wrong. He determines this by means of certain symptoms which indicate to him the nature of the trouble. The poultryman is in exactly the same position with respect to the health and condition of his flocks. In

Table 1. Recognition of the More Important Chick Diseases in the Field

Total Age, weeks	External Symptoms		Internal Changes		Disease Suspected	
	Sudden deaths following exposure; huddling		Congestion of lung and other organs, enlarged gall, legs bones soft, no food in intestinal tract; kidneys normal in size but pale, liver yellowish. Tissue in navel region bloody or waterlogged; ad- herent large egg yolk; enlarged yellow liver.		Chilling or overheating (ex- posure).	
1 or less	Swelling in navel region; stunted; sudden death.		... .. Large streaked liver; large cheese-like egg yolk; nodules on heart or in lung; air sacs normal; cheese-like material in blood galls; kidneys swollen.		Navel ill (pusky chick dis- ease), page 32. Sore eyes, page 31. Pullorum disease, page 32.	
0-3	Wet and dirty around eyes.					
1-3	Whitish diarrhea, pasting-up, droopiness, gasping, sweating.					
1-3	Yellowish diarrhea, pasting-up, droopiness		Large egg yolk containing dirty-yellow fluid, en- larged gall.		Common diarrhea, page 32. Gout, page 31.	
1-1	Dunpish, sudden deaths.		Swollen pale kidneys, whitish material on heart sac.		Nutritional pruritus, page 135.	
2-4	Inward curled toes, lameness in both legs, squatting.		Good flesh, sometimes slight jaundice of breast muscle.		Infectious cold (coryza), page 273.	
2-4	Running nose, watery eyes, gasp- ing		Mucous in mouth and nasal passages, occasionally yellowish air sacs of lungs.		Infectious bronchitis, page 266.	
2-7	Large crops, droopiness, poor growth.				Chronic respiratory disease, page 272.	
2-8	Eyes shut. Gasping.				Sour crop (fungus infec- tion), page 275.	
Any time	Coughing, sneezing, slight nasal discharge. Mortality very high. Twisted neck, partial or com- plete.		Thick whitish to grayish false membranes in crop; ulcerated gizzard.		Capeeworms, page 30. Newcastle disease, page 279.	

3-7	Bloody diarrhea.	Blind guts filled with blood or cheesy material, carcass anemic.	Acute or caecal coccidiosis, page 28.
3-10	Weak, droopy, head and comb pale.	Hemorrhages in muscles and internal organs.	Hemorrhagic disease, page 31.
4-	Diarrhea, droopiness, poor growth.	Reddish to whitish dots or streaks on the outside of intestine; swollen mucous membrane of intestine tinged with blood.	Intestinal coccidiosis, page 272.
4-	Walking on hocks, shanks twisted, deformities of legs.	None in internal organs; tendons of hock joint misplaced.	Slipped tendon (hock disease, perosis), page 110.
4-10	Lameness in both legs.	Thick joints, soft bones, crooked breast bone.	Rickets (vitamin D deficiency), page 134.
4-10	Poor growth.	Prominent follicles, whitish membranes in esophagus; swollen pale kidneys.	Nutritional roup, vitamin A deficiency, page 134.
6-	Lameness usually in one leg, droopy wing, paralysis of crop, blindness.	Enlarged leg or shoulder nerves, occasionally tumors.	Lymphomatosis (neural), page 278.
6-	Greenish diarrhea, poor growth.	Large cheese-like material in blind guta, cartwheel-like yellowish round areas in liver.	Blackhead, page 30.
Any time	Bloody toes, tail or abdomen		Cannibalism, page 281.
Any time	Blisters about head, comb, and wattles, later turning black and resembling warts.		Chicken pox, page 268.
Any time	Plumage rough. Poor growth.		Intestinal worms, page 286.
	Body thin. Pale shanks and beak. Inactive and weak.		Lice, page 283.
2-7	Head retractions. Somersaults.	Good flesh; body organs normal; small brain enlarged, watery, showing hemorrhages.	Mites, page 285.
			Crazy chick disease (encephalomalacia, vitamin E deficiency), page 136.

¹ Taken largely from *Bull.* 202, Storrs Agricultural Experiment Station, by permission of Dr. Erwin Jungherr. Corrected and approved by Dr. Jungherr, 1954.

his daily work with them he must be constantly on the watch for signs or symptoms of trouble.

Diseases and troubles to which chicks are susceptible are discussed in this chapter and in Chapters 14 and 15. Table 1, showing the common symptoms of chick ailments, should aid the poultryman in keeping on the lookout for troubles and in diagnosing diseases when certain symptoms are observed. For quick reference, page numbers in this book are given.

1. Acute or caecal coccidiosis (*E. Tennella*)*

The acute form is a common disease. Under moist, warm conditions the organisms go through a necessary period of development



FIG. 21. A flock of chicks suffering from acute coccidiosis. Note two nearly dead lying on the floor, and drooping wings on chick at lower right.

(24 to 48 hours), after which they can infect chicks if picked up. Since warmth in the brooder is necessary, the cycle must be broken by keeping dry conditions where the chicks are.

Symptoms: In mild cases, the chicks appear listless and droopy, the feathers rough, shanks and beak pale. Droppings are frequently bloody. Bloody droppings may not be positive evidence but are very indicative of the presence of coccidiosis.

Post-mortem examination usually shows enlarged caeca. The color of the contents varies from a bloody brown to a light yellow, and the consistency from a pasty to a cheesy mass. The only definite way of determining whether or not the disease is present is by a microscopic examination of a minute quantity of the caecal scrapings and coordinating these findings with gross lesions

* Chronic or intestinal coccidiosis is discussed on page 272.

of the intestinal wall (Fig. 22). There is seldom any difficulty in diagnosing the disease by the appearance of the chicks considered in relation to their age.

Cause: Acute coccidiosis is caused by a microscopic organism which works in the intestines, destroying the mucous membrane of the caeca. The infection must enter the body through the mouth, large quantities of the parasites (several thousand) being necessary to produce trouble. Coccidiosis, once started, spreads rapidly.

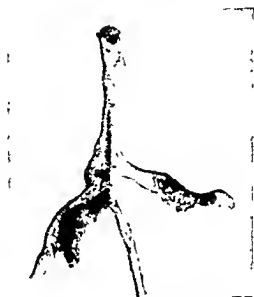


FIG. 22. The caeca, showing symptoms of acute coccidiosis.

There appears to be little reason for losses from acute coccidiosis. It has been many times demonstrated that dry quarters, around the water dishes and elsewhere in the house during brooding, with proper management otherwise, greatly reduce, if they do not completely remove, the danger from coccidiosis. Kennard * and others believe that compost litter, when properly used, is important in the control of coccidiosis. As this edition is prepared, interest is spreading in the method of piling compost litter to heat for several days

*D. C. Kennard, "Compost (Built-up) Litter as a Sanitation Procedure," *World's Poultry Sci. J.*, January-March 1954. According to Kennard, compost (built-up) litter starts with new built-up litter and is used continuously for succeeding broods of chicks, broilers, or layers. Its sanitation properties are realized after it has been used by two to three broods of chicks, or by layers for six months.

between broods, as practiced in the British Isles.* Until more experimental data are available, the safest procedure is to start each lot of chicks on fresh new litter.

Prevention is best. Avoid damp places in the brooder by placing the water dishes on wire-covered stands, by stirring the litter daily, and by increasing window or ventilator openings to permit moisture to escape.

The most recent recommendation, should the disease strike, is 0.05 to 0.1 per cent sulfaquinoxaline in the mash. This is more quickly absorbed through the intestinal walls than previously recommended materials.

Caution: Continuous feeding of sulfaquinoxaline is unnecessary and uneconomical for replacement stock. It may be desirable in broiler flocks. At 0.2 per cent in the mash it is less effective, since the mash is not eaten well, being distasteful.†

2. Blackhead

Losses from blackhead among chicks occasionally occur. The organism is most often found where chicks 6 weeks old or more are required to live under filthy conditions.

Treatment: Correct conditions. Sulfaquinoxaline may be given as for acute coccidiosis.

3. Gapeworms

Symptoms: The neck is stretched out and the chick gasps for breath. It may shake its head and cough. Often it will stand or sit for hours with its eyes shut, gasping at regular intervals. There are no cold symptoms present.

Cause is a worm which fastens itself to the inside of the windpipe or tracheal tube. Inflammation of the tube results, and death by suffocation.

Remedy: Alternate ranges.

Individual treatment: The worms may be removed by holding the chick's legs between the knees, stretching the neck upward, holding the beak open with one hand, while with the other a twisted

* These are highly controversial subjects and are mentioned here in order that the reader will have heard of them as experiment stations and practical poultrymen uncover more truths about them, favorable or unfavorable.

† R. A. Bankowski, "Use of Sulfaquinoxaline as a Preventive Against Mild Outbreaks of Coccidiosis of Chickens Under Field Conditions," *Am. J. Vet. Research*, October 1951

horsehair, having a loop at the lower end, is pushed down inside the windpipe. Twist slowly as it is pushed in; when it is in the full length, draw out slowly, twisting at the same time. The worms may be attached to the hair and the chick relieved. A quill feather may be used, or redtop with side projections shortened to about $\frac{1}{4}$ to $\frac{1}{2}$ inch.

Chemicals inhaled by chicks have not been found effective in removing gapeworms, except in a laboratory test where barium antimonyl tartrate was used. This was 98 per cent effective.*

4. Gout

This disease is thought to be due to insufficient vitamin A or an excess of protein.

5. Hemorrhagic disease in chickens

This is a comparatively new disease condition in broiler flocks.

Symptoms resemble coccidiosis. The affected birds are weak and droopy, combs and wattles are pale. Ulcers of the legs are often seen. The disease is most common at 5 to 8 weeks of age, but may appear earlier. Mortality may reach 15 per cent. Sick birds generally die in 1 to 3 days. Muscular hemorrhages occur, the same type being found in the liver, heart, intestinal serosa, proventriculus, and gizzard. Kidneys are gray and swollen. Hemorrhage may appear in any muscular area, or it may not show at all or very little. Blood in the feces often causes the disease to be mistaken for coccidiosis.

Cause: Probably mismanagement. It often occurs in flocks which have been fed a high-energy antibiotic feed containing a coccidiostatic drug and sometimes additional coccidiosis treatment in the drinking water. Whether this is a mere coincidence or a contributing factor has not been determined.

Treatment: An accurate diagnosis is a necessity as treatment for coccidiosis presumably has no effect on the disease. Withdraw medicated feed and medicated water if warranted after diagnosis. Give feed high in alfalfa meal and also liver meal for about a week.

6. Intestinal worms

(See pages 286 and 287.)

* Wehr, Harwood, and Schaffer, "B. A. Tartrate as a Remedy for the Removal of Gapeworms from Chickens," *Poultry Sci.*, January 1939.

7. Lice

(See page 283.)

8. Mites

(See page 285.)

9. Mushy chick disease (navel ill or omphalitis)

Losses from this disease are generally small. Infection of the navel may occur at time of hatching. No treatment is known. Prevention is recommended by formalin evaporation method, page 362, and by thoroughly cleaning and disinfecting the incubators between hatches.

10. Newcastle disease

(See page 279.)

11. Ordinary diarrhea

Symptoms: The first symptom noticed is a listless attitude; the wings droop, and the chick appears sleepy. The feathers around the vent become pasted up with a whitish or yellowish material, which may accumulate into a large amount. Usually there is considerable mortality, several chicks dying at night under the hovers. The chicks lose their appetite and fail to grow; in fact, they appear to become smaller.

This disease is often confused with pullorum disease.

Cause: The trouble is due principally to overheating, chilling, or other mismanagement which lowers the resistance and permits certain bacteria to gain a foothold.

Remedy: Correct the conditions.

12. Pullorum disease

When a flock of chicks is once infected, the disease proves very destructive. Most of the mortality occurs during the first week, although losses may continue for 3 or 4 weeks or longer, in fact throughout life.

Symptoms: The symptoms are the same as those listed under ordinary diarrhea, except that there is sometimes more of a tendency for the chick to utter a peculiar chirp or twitter when attempting to void the excreta. This is apparently a cry of pain. The chick breathes hard and has drooping wings and a sleepy attitude. The body assumes a short, round, blunt appearance (Fig. 23).

Cause: Pullorum disease is caused by the organism called *Salmonella pullorum*. The chicks that start the trouble are infected with the organism when hatched. This occurs as follows. When a chick that is infected with the organism survives and develops into a layer, the organism may, and usually does, localize in the ovary, which is the principal seat of the trouble. When an egg is



FIG. 23. Chicks infected with pullorum disease. Cornell University.

laid by one of these "disease carriers," the organism is in the yolk. Hence, the chick when hatched has the disease germs in its body and on its down, as *Salmonella pullorum* is present in the liquid surrounding the embryo in the egg. The diseased chick quickly spreads the infection to other chicks in the incubator, through the droppings and through their breathing the germ-laden air, especially during the first 4 days (Fig. 24).

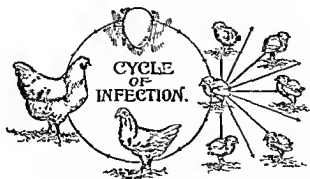


FIG. 24. Diagram showing how pullorum disease perpetuates itself in the breeding stock. University of Connecticut.

Treatment: There is no known cure for chicks which have the disease.

Remedy: The only sure way to prevent the disease is to use eggs from stock that has been tested for pullorum and no reactors found.

Pullorum disease can enter a clean flock only through the introduction of new stock, chicks, or eggs.

A means of testing hens has been found, by which those infected with pullorum disease can be detected. The *tube agglutination test* is a blood test of each individual; it is made in a laboratory. To draw the samples of blood, ship the samples to a laboratory, conduct the test, and return a report of the test to the flock owner requires several days.*

Experiments prove that the test is reliable. It may be necessary, if infection is found, to test two or three times in order to locate definitely all birds having the disease. One test will tell whether the flock is infected; if it is found to be so, other arrangements may be made accordingly.

The *whole blood rapid test* is nearly as accurate as the slow tube test, and is in wide use because it is quick and requires less handling of the birds. Under controlled conditions of temperature and dust-free air, a drop of blood is drawn from the bird onto a special board, and the proper antigen is added. Results are read before the bird is released.

The *rapid serum test* consists in applying serum to the antigen and reading soon afterward. Follow directions issued by the laboratory of poultry diseases in your state.

13. Sore eyes

Sore eyes frequently develop in a flock of chicks. The eyes water freely, dust clings to them, and hence the eyes have a dirty, pasted appearance. The trouble results from material getting into the eyes and irritating them. Fine chaff or barn-floor sweepings for litter are frequently the cause of the trouble. Because certain seeds have prongs which are sharp and rough, hay chaff is not a desirable litter.

If litter under the hover contains considerable manure, it may give off ammonia fumes which, if prolonged, may cause blindness. Remove the litter under the hover and replace with new unused litter. Check the ventilation of both hover and room.

Community Survey

1. What causes the greatest chick loss in your locality?
2. At what age does the greatest chick mortality occur?

*A description of the test will be found in the Report of the New York State Veterinary College Cornell University, 1925-1926, pp. 131-144.

3. List the diseases that are prevalent.
4. List the mechanical ways in which local poultrymen have lost chicks.
5. What means have been taken to prevent these mechanical losses?
6. Ask the local veterinarian if he has had occasion to use a test for pullorum. If so, how does he test?
7. What per cent of the chicks are missing or die during the rearing season?
8. Are nearby hatcheries in the National Poultry Improvement Plan (NPIP)?
9. Are they in the pullorum phase of the Plan? If not, why?
10. List the hatcheries or breeders in your state that are in both parts of the Plan.
11. How many not in the Plan do their own breeder selection? Pullorum testing?

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Caring for Young Stock Past the Brooding Period'

A selected flock of pullets is the pride of the poultryman's heart. In them is represented his future business. There is nothing that brings him greater joy than watching a flock of partly grown stock with healthy, smooth-feathered bodies and clean-cut, intelligent heads, and realizing that the dangers and uncertainties of rearing are largely past. To watch such a flock feeding or resting in the shade of a proper range, and to visualize the fine prospective egg producers he has labored for, or to see them under spacious conditions of confinement rearing as their bodies grow and their combs gradually approach those of laying pullets, is the delight of every true poultryman, and is an experience that he has earned a right to enjoy.

With proper rearing conditions, it is cheaper to grow stock than to buy it. Pullets of equal quality will ordinarily cost about one-third more than their rearing cost if purchased.

Operations:

1. Rearing in confinement.
2. Separating the sexes.
3. Using the catching crates.
4. Range rearing.
5. Feeding the young stock for healthy growth.
6. Providing ample ventilation
7. Controlling lice, mites, and natural enemies
8. Educating the pullets in nesting habits
9. Providing a cool, clean, constant water supply
10. Moving pullets to permanent laying quarters

1. Rearing in confinement

Like confinement brooding, confinement rearing has been made possible, desirable, and economical by advances in nutrition and breeding. Through it, the acreage need, dependence on seasons, and usual range losses are practically eliminated. The distribution of labor throughout the year, the possibility of regulating egg production to obtain the best egg prices, and a more efficient use of buildings are advantages over range rearing.

Sexed pullet chicks are preferred unless extra room is made available for holding cockerels when separated from the pullets.

Confinement rearing, as in proper range rearing, requires the right amount of space, precautions against disease, including protection by vaccination or immunization, and controlled water supply.

It is recommended that pullets be given extra room at 8 to 10 weeks of age by access to an overflow room or building which, later the same season, will be used as a barracks by hens; or that the pullets be moved to the permanent laying quarters.

2. Separating the sexes

When sexed pullets are purchased, the few cockerels found among them may be removed and used at will during the season. Straight-run chickens must be handled differently.

Pullets develop better when by themselves.

Leghorns and other rapidly growing varieties develop sexually very early and the males soon become annoying to the pullets. For this reason, and also because they are taking up room, the cockerels should be removed from the flock when they are 3 to 6 weeks old. At this age the cockerels can easily be detected by their larger combs and wattles, red faces, and actions. Keep cockerels in separate pens and market as broilers, roasters, or capons, depending on the variety and market.

In the heavier varieties sexual development is slower. The cockerels should be separated at 5 to 8 weeks of age.

If the chickens are brooded in large permanent quarters, they may be caught for either separating sexes or moving to the range by penning in a corner 15 to 25 at a time, using a wire screen or panel, or by means of catching crates.

3. Using the catching crates

Catching crates may be used with any type of building. If the exit is not in a corner of the building, place a temporary partition to make a corner while driving the chickens out into the crates.

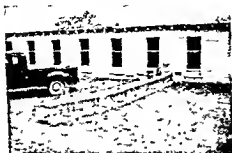


FIG. 25 Catching crates with both ends removable, placed end to end at the exit, for use when moving or sorting birds.

Keep the chicks confined the morning the flock is to be separated. Place a catching crate outside at the exit door. Open the door and let the chicks run out into the crate. When a sufficient number is in the crate, close both the exit and the crate doors. Use several crates end to end to simplify the work.

The chicks are now ready to be sorted. Remove both pullets and cockerels that are not developing properly, that show low vitality, are not properly feathered out, or otherwise do not measure up to a high flock standard of quality. Place the culls in other crates or carrying boxes and release the desirable pullets. Only a short time will be required for each house (Figs. 25, 26 and 27).

Handle all birds carefully while doing this work. Serious injury is likely to result if chickens, especially pullets, are handled roughly.



FIG. 26 Other crates are available and the pullets graded, cockerels removed, etc

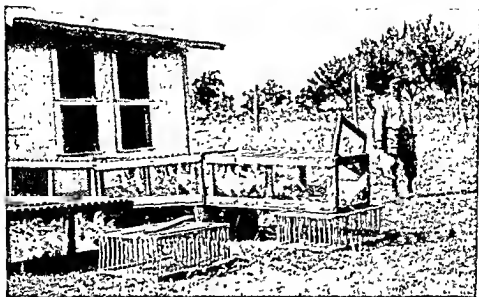


FIG. 27. Any remaining birds are allowed to run out, before the crates are again filled.

4. Range rearing

A range should provide exercise, shelter, green feed, water, shade, sunshine, and safety (Fig. 28).

Some provision should be made for shade on every range where natural shade is lacking. Place burlap, brush, or metal roofing on a frame supported by poles. Plant corn or sunflowers along the border of the range for shade.



FIG. 28. Open-air shelters spaced for complete use of a bountiful range.

When the chicks are moved to the ranges, the colony houses or range shelters should be at least 100 feet apart. This will require about 1 acre for each four shelters with about 125 pullets to each

shelter. A trip to the various shelters can be made in less time if they are arranged in a square rather than in a row, and better use of a given field is ordinarily provided. Moving the shelters about the range several times during the rearing season helps preserve the pasture.

Keep the chickens of different ages on separate ranges or on widely separated parts of the range until they are 2 or 3 months old. The best results cannot be secured where young chickens of different ages, extending over a period of several weeks' hatching, run together. This is particularly true during the early stages but applies throughout the rearing season. The older birds misuse the younger ones and eat their feed.

5. Feeding the young stock for healthy growth

From 8 to 18 weeks, approximately, growing rations are needed. See Chapter 7 for ingredients, amounts, and method for determining growing rations.

If chicks are fed as recommended, the essential nutrients will be supplied for both range-reared and confinement-reared pullets. Note the difference in the rations, page 125.

Table 2. Feed and Time Required to Obtain Certain Average Live Weights with Common Breeds of Chickens¹

Average Live Weight, lb.	Kind of Chicken and Quantity of Feed Required per Bird		Kind of Chicken and Age at Which Certain Live Weights Are Reached	
	White Leghorn Females, lb.	Heavy Breed Females, lb.	White Leghorn Females, weeks	Heavy Breed Females, weeks
0.5	1.0	0.8	3.8	3.2
1.0	2.5	2.2	6.0	5.4
1.5	4.3	3.8	8.6	7.2
2.0	6.3	5.3	11.2	8.7
2.5	10.6	7.2	14.6	10.0
3.0	15.6	10.0	19.2	11.3
3.5	24.3	12.3	26.6	13.6
4.0		17.3	30.8	
4.5		22.0		
5.0		29.0		

¹ From *Nutrient Requirements for Domestic Animals*, "Nutrient Requirements for Poultry," revised January 1954, a report of the Committee on Animal Nutrition, Agricultural Board, National Academy of Sciences, National Research Council Publ. 331.



FIG. 29. A desirable range feeder, easily constructed, 6' long and 9" to 15" wide.

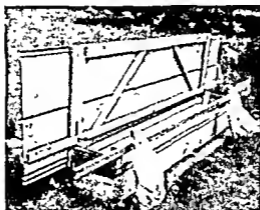


FIG. 30. Same feeder as shown in Fig. 29. Note metal roof 2' \times 8', open to permit filling or cleaning, 1" \times 2" \times 8' handles, and space below handles for the birds to feed. The sides are 8" high. Corner posts are 2" \times 2", and 2" \times 2" pieces are nailed to the bottom to raise the feeder box from the ground and to support the standing board

Outdoor hoppers (Figs. 29 and 30) with compartments for grain and mash should be placed near each house, and a hopper of grit should be provided.

Grain may be hand-fed on clean soil in dry weather, but hopper-feeding is more sanitary.

Pullets should always go into laying quarters well developed and fat. *At 18 to 20 weeks, change from growing to laying rations.*

6. Providing ample ventilation

An open range shelter will protect the chickens from the heat and storms.

It is scarcely possible to overemphasize the need for an abundance of fresh air, day and night. Developing pullets should never be compelled to pass the hot summer nights in an overcrowded and poorly ventilated house. Such treatment prevents normal growth

and development, and may be the chief contributory cause of disease.

For rearing on range, use portable brooder houses only as a last resort. If they must be used, remember it is hardly possible to get too much air movement during summer in a brooder house. During summer and after the chicks are through with artificial heat, remove all windows. Open both front and rear ventilators. Leave the windows and ventilators open until the pullets are moved to their permanent quarters early in the fall.

Face the house or shelter so that the front will be best protected from the wind and rain. In many locations, this will mean that the house should face toward the east. This will also make the house cooler than if it faced south.

Frequently the most natural and most satisfactory place for pullets or cockerels to rest during the day and roost at night, until the time when they are placed in winter quarters, is in the trees of an orchard unless coons, owls, or other predators are a problem.

7. Controlling lice, mites, and natural enemies

Protection against parasites and predators means better growth



FIG 31. Coons at large and growing a family are death to growing pullets

and health and more pullets. Never let lice, mites or other parasites which feed on and irritate the body get a start. Control is not difficult. When perches are used, treatment consists of purchasing preventive material and properly applying it. It appears unnecessary to handle each bird. Purchasing the preventive is less costly.

Should mites, fleas, or ticks become so numerous as to inhabit the litter or cracks in the walls, a weakness in management is indicated.

Coons may climb trees at night, scare the pullets out, then catch them on the ground. Large owls may be a menace. In this case, shut the birds in houses or shelters at night. Should

loose continue from natural enemies, confinement rearing may be the best remedy.

A 38-inch standard horizontal wire fence, fastened to the inside of

the posts, with an *electric charged wire* on insulators on the outside, 3 inches away from the fence and about 5 inches aboveground, is an aid in preventing trouble from foxes. The grass must be kept mowed under and around this to keep it from coming in contact with the charged wire.

In many localities the danger of losing chickens by theft is great. A spotlight often proves useful. A good watch dog, either chained to a kennel or at large, is likely to be a profitable investment. Electric alarms, either opened or closed circuits, connecting the rearing houses with the caretaker's room have proved desirable.

Tattooing the web of the wing with an identification number, recorded with the state police and sheriffs, is effective. Such organized tattooing plans are in use in many states. Consult your state poultry husbandry department or the state police for information about plans to prevent theft.



FIG. 33. A convenient nest if laying starts before pullets are housed.



FIG. 32. The tattoo marks are left on the web of the wing by the marker. Tattooing may be done at the time range birds are vaccinated for chicken pox, or at any other convenient time.

When it is generally known throughout the neighborhood that the above special precautions against stealing have been taken, that fact, in itself, is the best insurance that would-be chicken thieves will consider it safer to steal elsewhere.

8. Educating the pullets in nesting habits

It is sometimes necessary to leave pullets on range until after laying commences. To avoid later difficulties of floor eggs, egg breakage, egg-eating habits, and cannibalism, train pullets while on range by providing suitable nesting places for any early layers (Figs. 33 and 34).

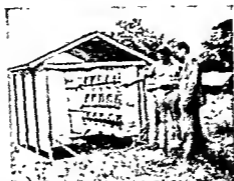
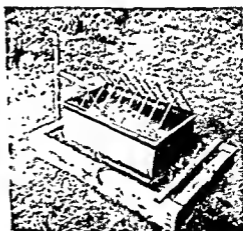


FIG. 34. Device for holding metal nests on the range if pullets are not housed before laying commences. Here pullets are caught in the nest and transferred to crates. Each day's catch is placed in the laying house. This system avoids catching pullets out of trees at night, and it automatically leaves the slower-maturing birds on the range.



A



B

FIG. 35. Types of range waterers. A. Barrel-supply feeding by float valve into a concrete receptacle. B. Water piped to the range and supplied by an automatic float.

9. Providing a cool, clean, constant water supply

On range, natural or piped running water is best (Figs. 35 and 36). Other methods are a water pan and float on wire-covered floor, or a water barrel with faucet set to drip or used as a supply to fill shaded pans.

Reared in confinement, the pullets quickly become accustomed to the watering system installed.

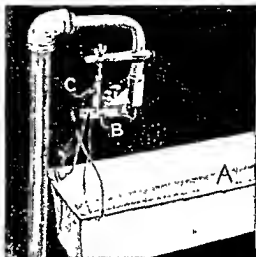


FIG 36 A constant supply of water may be assured by an automatic valve. As the water in the trough A is used, the weight on the arm B lessens and the spring C pulls the arm up, thus letting water flow into the trough. Manufactured by White Manufacturing Co., Gardena, Cal.

10. Moving pullets to permanent laying quarters

Pullets hatched in the spring and range or confinement reared are housed in the fall, after the hens are sold or transferred.

Pullets hatched in the winter months should be housed before the laying hens have finished their laying year. Do not sell the hens to make room, but move them to other quarters to continue laying until sold or sorted in the fall. Move the hens sometime between early spring and July. Their production will be disturbed very little.

In this method, both pullets and hens are placed on the litter previously used. Stretch poultry wire to make temporary pens. Feeders, waterers, and nests must be in place. Interchange hens and pullets from laying house to brooder house, preferably at night, *handling them carefully*. Then remove the temporary pens.

The *pullets* are now in permanent quarters, preferably before laying starts, where they remain until the following season. The *hens* are in barracks, where they finish their laying year and remain until sold, except that the best hens should then be moved to other quarters for rest and a second year of production.

When pullets are reared in confinement, other methods may be used. Two of these are described in the following paragraphs.

Have extra barracks available for hens. The pullets may be left in the enlarged brooding and rearing area until the laying pens are

cleaned and disinfected, then moved in when convenient. The usual preparation of brooding quarters is easily provided in confinement rearing by allowing a month to elapse between the time adult birds are removed from the brooding quarters and new chicks are put in.

Practice alternate brooding between permanently located brooder and laying house. In this plan, pullets stay in their brooding and rearing area through their entire first laying year, or until approximately 2 years old. The brooders or heaters, if portable, would be moved for the brooding period to the brooding quarters used in any season. For example, if chicks were purchased December 1 each year, the hens which had occupied those quarters for 2 years, or since they were chicks, would be moved out November 1 and sold or held in another building for their second year of production. The brooding space they had occupied for 2 years could then be cleaned, disinfected, and made ready for the new chicks by December 1, one month having been provided for the brooder preparation. Next year the layers in the second building would be handled in the same manner on November 1, and the brooding space prepared for the new chicks arriving December 1.

The various plans for use of buildings and methods in confinement rearing are too numerous to give here. The reader is referred to the chapter on "Systems of Flock Replacement" in *The Economics of Poultry Management*, published by John Wiley & Sons, New York.

Community Survey

1. What is the largest number of pullets grown on a single local farm?
2. How many chicks were required for each pullet reared to laying age?
3. What percentage of the chicks at start were males?
4. What provision is made for summer range?
5. Describe the type of range house used
6. What method is employed for keeping the rearing houses cool and well ventilated at night during the summer?
7. Do the pullets roost in trees?
8. If so, how are the pullets caught when placed in the laying houses in the fall?
9. Describe the rearing ration and method of feeding used by local poultrymen.
10. At what age are the cockerels, if any, separated from the flock?
11. How many poultrymen transfer to "Bachelors' Hall" cockerels that are to be used as future breeders?

12. What is the basis upon which these cockerels are selected?
13. Are the young birds culled during the rearing season?
14. What points are regarded as desirable? As undesirable?
15. Inquire if poultrymen have experienced any losses from chicken stealing.
16. If stealing has occurred, were the thieves apprehended, and how?
17. Losses from foxes, coons, dogs, owls, or other predators are sometimes considerable. If experienced, how are such problems met?

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Housing Laying and Breeding Stock

Operations:

1. Preparing the house for new pullets.
2. Placing the birds in the house.
3. Operating the house.
4. Deciding between single- and multiple-story laying houses.
5. Constructing a laying house.
6. Installing poultry house fixtures.

1. Preparing the house for new pullets

Several methods are in use.

The newly constructed house. Wood floors, droppings boards, perches and wooden nests should be painted with Carbolineum or other equally desirable product, to prevent parasites from gaining a foothold and to preserve the floor and other parts where moisture may gather. Do this one or more weeks in advance of the time pullets are put in, to permit dangerous gases to escape, avoid burning the bottoms of pullets' feet, and reduce the danger of imparting off flavor to eggs.

The used house starting like a new house. Many poultrymen prefer to place the used poultry house on a similar basis to the new house with respect to cleanliness. Following are practices in use to accomplish this.

With hoe and broom, scrape and sweep clean the interior fixtures. Scrape the nests, droppings boards, equipment, and floors free of all material. Sweep the ceiling, walls, windows, equipment, and floors free of cobwebs, dust, and other debris. Remove the dirt and litter thus accumulated.

Then paint the roosts and nests, making them mite-proof. One of the best materials for this purpose is Carbolineum.

Apply Carbolineum with a brush, painting perches, supports, and the inside of the nests. These should be allowed to dry for at least

24 hours, before they are occupied by the birds, to avoid injury due to blistering the skin or breathing the fumes. Care must be exercised by the one who applies Carbolineum to avoid irritation to the eyes, nose, and hands. If Carbolineum cannot be secured, apply some good coal-tar disinfectant, full strength.

The used house with old litter. If built-up or compost litter 8 to 12 inches deep was used the previous year and time has elapsed



FIG. 37. Eventually cleaning must be done to reduce floor weight and increase room height. This pen above a cow stable is cleaned through the small door.

between the interchange of hens and pullets, treat the house as directed in the preceding paragraph, except the floors.

If the hens and pullets are interchanged simultaneously, perches may be scraped of manure and treated during any morning, the nests examined carefully and treated alternately, treating and closing part of them for a few days, then opening for use while others are treated.

If the litter is infested with mites, fleas or other parasites, it should be removed and carted as far away as feasible; the floor, if of wood, should be painted with Carbolineum or sprayed with Lindane or other miticide; and new built-up litter should be started.

When compost litter (page 90) is used, some litter should be removed each year to keep its depth within reason, 6 to 7 inches when pullets are put in. Remove from the top at the deepest points, and if the night droppings fell to the floor in the past year, clean to the floor in those areas and replace with litter from other parts of the floor.

Provide interior fixtures for laying, eating, drinking, and resting. Each 100 layers should have, in lineal feet, approximately the



FIG. 38. 7500 layers in this pen, 60' \times 350', distribute themselves well. Note trough of running water in center, feed troughs on either side, nests to the left, and perches far left. Courtesy G. F. Johnson, Pennsylvania State College.

following: *nests*, 20; *mash* feeding space, as high as 40 when feeding all-mash; if feeding grain and mash by trough, then mash, 24, grain feeding space, 24; *shell* feeding space, 4; *grit* feeding space, 1; *perches*, 60 for light breeds and 70 for heavier varieties. (Night droppings may fall on boards, into pits, or on the floor litter.)



FIG. 39. Grit and shell containers built between studs.

In addition, provide one *watering pan* 18 inches in diameter if a continuous flow of water is available or if a float valve can be used. This will accommodate up to 300 hens.

One *automatic jet waterer* for 150-200 layers appears sufficient (see A of Fig. 59).

If all grain is fed at night, birds may

rush to the water directly after, and more waterers may be needed or other auxiliary types should be made available for those few hours of the day.

Install one *light* for each 200 square feet of floor space, 15-watt lights for all-night use, or 40-watt lights for 13 or 14 hours of day-light and electric light combined.

Repair and clean windows. If cloth curtains are used in place of glass windows, repair them if necessary with cheesecloth or muslin.

Glass windows should be repaired, cleaned, and stored until cold weather arrives.

Provide litter and nest materials. Put 3 to 4 inches of clean litter on the floor and add more from time to time as it becomes well broken, until it is 6 to 8 inches deep. When the litter is left in until the next year's pullets are housed, it is called built-up litter. If the litter is left in for several years, it is called compost litter. The common straws for litter, in the order of their desirability, are wheat, rye, oat, and buckwheat. Shredded or cut cornstalks, shavings, ground corncobs, dried sawdust, shredded sugar cane, or peat moss may be used if straw is not available. Straw or cut cornstalks mixed with shavings make a fluffy, loose litter. The ideal litter is one which is durable, does not pack readily, and permits moisture to evaporate quickly.* Leaves pack and are less desirable.

Be particularly careful that the litter used is free from mustiness, mold, or decay, as serious trouble may develop in a flock where this precaution is not heeded.

Nesting material should consist of 4 to 5 inches of shavings, oat or buckwheat hulls, or cut straw. Excelsior pads are used in some areas.

The house should now be ready. If the back, roof, sides, and floor are tight, and the front permits a good circulation of air without draft upon the birds, it should be comfortable.

It should not be necessary to completely change litter during the winter, but if it is necessary, check the causes. Do not replace

*Recent experimental work shows that chunky wood chips 1 to 2 inches in circumference, by-products of wood slabs and pole wood, permit fecal material to dry and sift to the bottom and give sufficient space for aeration. A special wood-chipping machine is required. These are not ordinary shavings. (W. A. Aho, "Woodchips for Poultry Litter," abstracts of papers, Poultry Science Assoc., Univ. Michigan, 1955, p. 1.)

with long straw; it gets damp within a few days because moisture does not evaporate from it readily.

2. Placing the birds in the house

Allow 3.2 square feet of floor space per bird for Leghorns and other light varieties, and 4 square feet for heavier varieties. The use of *range* for laying pullets or hens has been practically abandoned by commercial poultrymen with flocks of 300 or over. Smaller laying flocks, generally not commercial, are often not confined.

Range pullets. As pullets approach laying condition, the more advanced ones with similar comb development should be placed in permanent laying quarters. Leave the others on range for further development. The very late-developing pullets, of which there should be only a few, may be confined in a separate pen until they mature, when they may be placed in the main pen or sold or used for meat.

Handled as outlined, the pullets have the time they need to learn where nests, feeders, and waterers are located and to come into production normally.

Give ample food. Pullets continue to grow for several months after laying commences. Feed both grain and mash in hoppers for 2 to 4 months at least.

It is good practice to mark a dozen pullets in each house with leg bands or paint, and weigh and record the weight of the same birds every 2 weeks as a guide to the condition of the flock.

If pullets are not gaining in weight or at least maintaining their weight, feed a moist mash or pellets or extra grain.

Control lice and mites. Range pullets and cockerels should be free of lice and mites and will remain so if the house is properly prepared. Black Leaf 40 is recommended for lice, and Carbolineum or Lindane for mites.

3. Operating the house

The main points to watch in either single- or multiple-story houses are dryness of litter and purity of air.

Change the air. If the weather is mild after housing either range or confinement-reared pullets, leave the houses open at the front, rear, and ends for several weeks, if possible, in order to continue open-air conditions.

The front and rear rafter-outlet type of ventilation, similar to

that shown in Figs. 71 and 72, is desirable for either roofs sloping to the rear or flat ceilings, in either 1- or 2-story houses.

As cold or windy weather approaches, close both front and rear ventilator boards and put the glass windows in place, especially at the rear. The shortened ventilator board (Figs. 71 and 72) in front ensures an air outtake when the board is raised. On days when storms blow into the house or the temperature approaches zero, it may be necessary to close the front curtained windows for a short time. At all other times, leave them open. This should allow plenty of fresh air and sunshine, provided there is sufficient curtained window space for the size of pen and number of birds. (See page 72.)

Glass windows may be used to replace all or part of the curtained windows as in the Connecticut house, page 81. In this case rafter ventilation is used and the glass windows can be moved up or down as suggested for curtained windows.

Fan ventilation... Provide adequate intakes and follow directions.

4. Deciding between single- and multiple-story laying houses

Both types have their strong advocates. The decision may rest on climbing stairs versus walking on a level. In multiple-story house, stairs should *not* be the narrow, steep kind too often found, but should be built with 6-inch risers and 11 to 12-inch treads. An elevator may be desirable. Ceilings need not exceed $6\frac{1}{2}$ to $7\frac{1}{2}$ feet above the floor, the height depending largely on how tall the operator is, depth of litter, and whether a cleaning truck is to drive onto the first floor.

Barns may be remodeled or new structures built. Buildings 36 to 40 feet wide or wider will be interchangeable for other purposes, such as dairy barns, if and when desired.

Other features of multiple-story laying houses are one roof and one foundation for two or more floors, and a more compact structure housing several times the number of birds that can be kept in single-story buildings on the same ground area. The cost per bird for ground, structure, and water piping is reduced, but this is partly offset by the cost of heavier foundation, framing, elevated feed bins, an elevator, and stairways.

With this type of building, miles of travel in a year are less in caring for the same number of hens. Pen cleaning on upper floors may be through trap doors opening into wooden chutes outside, or

canvas or wooden chutes inside leading into a truck on the first floor.

Less water pipe is required for extending upward 7 to 8 feet to each succeeding floor than for crossing the pens in long single-story

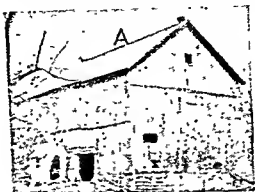


FIG. 40. A. The barn shown in B before remodeling. B. Barn remodeled into a four-story laying house. Air intakes through curtain openings. Air outtake is in front at the ceiling as shown in Fig. 71.

houses. Electric heating cable can be used more economically and efficiently.

Flocks of only 500 to 1000 layers are best housed on one floor. For larger flocks, the multiple-story house may be considered.

5. Constructing a laying house*

Lay out the foundation. Locate a corner on the highest point of ground on which the proposed building is to stand, and about this

*In the poultry enterprise, the costs for buildings constitute a large percentage of the total poultry inventory. It is frequently desirable to remodel a shed, barn, or other building for convenience or to reduce costs, or both.

corner drive 3 stakes, as *A-B-C* in diagram, Fig. 41, approximately 3 feet apart.

Guided by a spirit level, nail boards on these stakes as shown, with the upper edge just 6 inches above the ground at the corner *D*. With the steel square as a guide, lay a line from *F* to *E*, which will be the direction of the desired frontage, and another line *G-H*, which will represent one side. Measure off the desired length and width of the house on these lines, and drive stakes about the corners. By means of the spirit level and straightedge, determine the level at *E-I-H-J* and nail boards to the posts at this level. In the same manner, find points *K-L* on the other corner. Lines may now

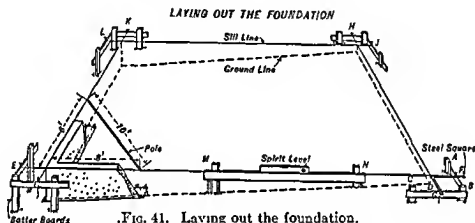


FIG. 41. Laying out the foundation.

be stretched between these points. As an aid, when the points are far apart, stakes may be driven in at intervals and boards nailed on at the correct level, as at *M-n*.

The 6-8-10 rule will assist in checking the square corners. Measure 6 feet in one direction and 8 in the other. If the two points thus determined are 10 feet apart, the angle formed is a right angle (Fig. 41).

Construct the foundation. (See *A, B, C, D* of Fig. 42, and *A* and *B* of Fig. 43.) Dig below the frost line. This may be 2 to 2½ feet in light soil or 3 to 4 feet in heavy soil. Latitude may influence these depths. The width of the trench should be about 18 inches if on fairly level ground, or wider if against a bank. A 4-inch drain tile may be placed as shown in Fig. 43. A few inches of stones to allow easy access to drainage water may be placed in the trench, or the footing may rest on the ground. Place the forms for the concrete, making sure that the top of the form is level and coincides with the line previously laid out. These forms should

canvas or wooden chutes inside leading into a truck on the first floor.

Less water pipe is required for extending upward 7 to 8 feet to each succeeding floor than for crossing the pens in long single-story

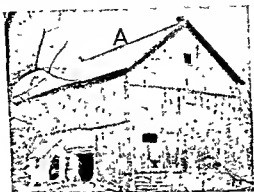


FIG. 40. A. The barn shown in B before remodeling B. Barn remodeled into a four-story laying house. Air intakes through curtain openings. Air outtake is in front at the ceiling as shown in Fig. 71.

houses. Electric heating cable can be used more economically and efficiently.

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corner drive 3 stakes, as *A-B-C* in diagram, Fig. 41, approximately 3 feet apart.

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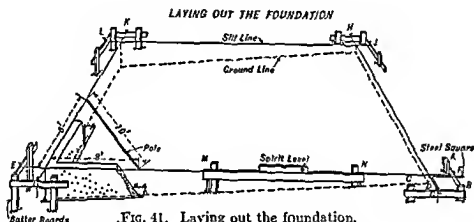


FIG. 41. Laying out the foundation.

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FIG 42. (Legend on opposite page.)



FIG. 42. Constructing a laying house.

A, note guide timbers and trench. First operation is preparing the foundation. B, trench partly filled with stones which act as the base for the wall. Part of the forms in place. C, a concrete mixing platform. Conveniently located for rapid placing of the concrete after being mixed. Water, sand, cement, and aggregate nearby. D, a piece of a 2×4 may be used to determine the height the bolts should extend above the wall. Anchoring bolt placed head down while cement is soft. E, sills bolted to the wall and placed on the outer edge of the wall. Corner post erected. A second 2×4 will be added, resulting in a 4×4 for the corner post. F, framing nearly completed. G, note front plate on edge and stud cut to fit. Rafter is notched to rest squarely on the stud and plate. H, rafters resting on center stringer. Both rafters should project beyond the stringer, thus making stronger construction. I, note rear plate on edge and rafter notched to rest on plate. J, the roof boards are nailed on and the ends evened later by sawing along a chalk line. K, roofing is laid from the rear toward the front. L, the front framework. M, a rear window opening and part of the roosting space ceiled. N, two-ply roofing paper laid on outside of the siding; aids in keeping the house warm in winter. O and P, the completed house, rear and front.

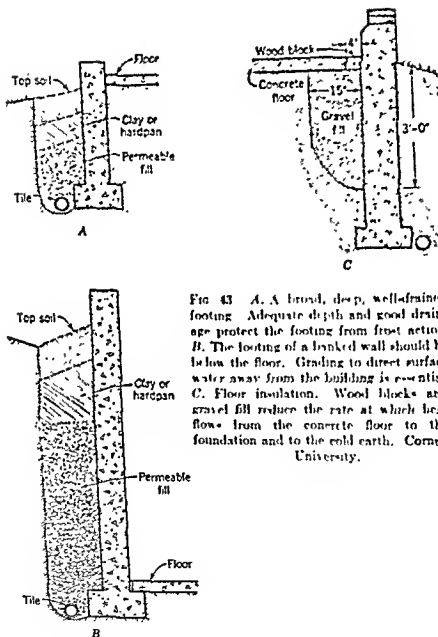


FIG. 43. A. A broad, deep, well-drained footing. Adequate depth and good drainage protect the footing from frost action. B. The footing of a banked wall should be below the floor. Grading to direct surface water away from the building is essential. C. Floor insulation. Wood blocks and gravel fill reduce the rate at which heat flows from the concrete floor to the foundation and to the cold earth. Cornell University.

be 6 inches apart, inside measurement, for single-story houses, or 8 inches for multiple-story houses. Fasten the forms at intervals to keep them from spreading after the concrete is poured. Nail cleats across the corners to prevent bulging.

Fill the forms with concrete. See page 97, "Concrete Foundations," for kinds and amounts of material to use and method of estimating. While the concrete is still soft, place $\frac{1}{2}$ -inch by 8-inch bolts every 5 feet, with the heads down, extending above the concrete 1 inch more than the sill thickness. These are to hold the sills in place. After 2 or 3 days, remove the forms and place on the foundation wall the sill with holes bored in it to take the bolts (*E* of Fig. 42). The outer edge of the sill should be flush with the corresponding edge of the wall. Fasten the sills down firmly with a washer and nut.

Concrete blocks laid on a level concrete footing make a desirable foundation.

Build a floor. A concrete floor may be laid after the siding and roof are on, or before the framework is erected. Drainage under the floor is necessary (*C* of Fig. 43). Next, a 2 to 3-inch layer of concrete should be added. Stretch a string from sill to sill to indicate the height of the finished floor. Lay 2 by 4-inch pieces parallel to the side walls or to each other to make sections 4 to 8 feet wide. Lay these on edge, with the upper edge flush with the string. Brace the pieces firmly by driving stakes or by nailing, or both. Fill alternate sections with concrete the first day, and the remaining sections 1 or 2 days later. Starting at one end, fill in a few feet of concrete. With a straightedge moving back and forth and at the same time slowly forward, keep the concrete level until the entire space is filled. Trowel the surface to make smooth.

6. Installing poultry house fixtures

Perches. The perches are usually placed at the rear of a 20 by 20 or smaller house, parallel or perpendicular to the rear wall. This permits a maximum amount of light on the floor beneath them when they are used with or without droppings boards and windows are in the rear wall. They are out of the way and in a protected position. In wider houses or pens, they are often placed part way or completely to the center of the room.

(1) *Distance and space required.* Place at least 8 inches above the droppings board if any. If built against the house, the rear

perch should be 9 inches from the wall, and the remaining perches 14 inches apart on centers. Birds of the Leghorn type require 7 inches of perch room; the heavier varieties need 9 inches. Various perch arrangements are shown in Figs. 44 to 47.

(2) *Material and construction.* For long perches, 2 by 3 or 2 by 4-inch material may be used, set edgewise and with upper corners rounded. For short perches use 2 by 2-inch pieces. Poles are sometimes used. They should be straight, stout, rounded, and about 2 inches in diameter.



FIG. 44. Perch arrangement. A portable droppings pit and perches. Note the pins for holding perches in place. The 1" X 4" wire permits the droppings to fall through but keeps the birds from them. Rats may accumulate in this protected space unless they are watched carefully or rat holes are provided.

To keep the birds from the droppings, No. 15 or 16 gauge 1 by 4-inch mesh wire may be fastened beneath the perches if desired.

Droppings boards may be removable and in sections or in units complete with perches. They should extend 6 or 7 inches beyond the outer perches. Place the boards perpendicular to the side, thus making them easier to clean, and 2 to 2½ feet above the floor.

Droppings may fall directly onto the litter on a concrete floor (B of Fig. 45), or into a pit from which the birds are excluded (Fig. 47). Ease of cleaning may be a determining factor in deciding which is best.

Nests. At least 1 linear foot of nest to each 5 layers is needed during the heavy laying season. Nests should be roomy, easily cleaned and serviced. Nest partitions divide nests into 1 foot lengths may or m: CENTRAL LIBRARY birds appear



A



B

FIG. 45. Perch arrangement. A. Units 8' \times 6', perches 14" on center, and droppings boards 11 $\frac{1}{2}$ ' above the floor. Material may be cut without waste. Perches are 2" \times 2" \times 8', five to each unit. May be placed end to end and against the wall or away from it. Easy to move. B. A series of roosting units consisting of frames for supporting the perches. Droppings fall to the floor. The birds keep the surface scratched over and, if desired, a few forkfuls of litter may be scattered over the droppings occasionally. This represents a cheap roosting arrangement. Ordinarily no increase in the number of dirty eggs is noted. Note double-deck feed hopper at right, 8" deep, 8" wide, and 5' or 6' long, grain below, mash above.



FIG. 46. Perches on slanting supports, more commonly used many years ago, shown here on a large Connecticut plant, 1955. Can be raised and hooked up for machine floor cleaning. Droppings fall to the floor. *Caution:* Birds fighting for space may fall and injure themselves.



FIG. 47. Triple-deck roosting units over droppings pits. Movable for cleaning. Cornell University.

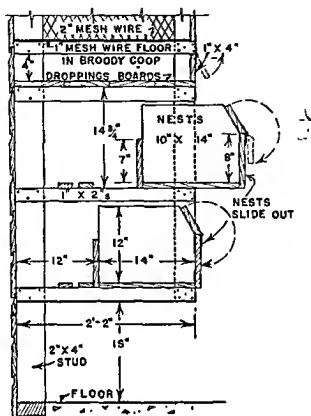


FIG. 48. A convenient and serviceable nest and broody coop combination.
Cornell University.

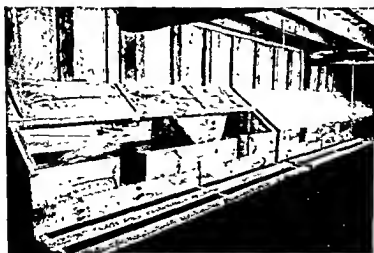


FIG. 49. A community-type nest. Compartments $4' \times 2'$.

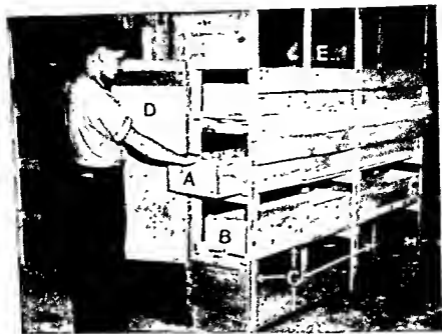


FIG 52. A nesting room being constructed. The completed room is shown in Fig. 53. A and B are trough nests 4' long and without partitions. Opening door D permits troughs to be removed for emptying, renewing nest material, or placing floor eggs in the nest. C will be equipped with an entrance door for the layers. E is the operator's entrance from an outside room. Note the siding which overlaps the bottom of the upper trough and the top of the trough next below. Since the trough slides inside the uprights, provision is made for some light and air to enter between the trough and the siding. Note the support for troughs also to the left.

Coops or pens in the house or nearby are frequently used to hold broodies, but should be located where the least amount of walking is required.

Feed hoppers. The ideal dry-mash hopper should (1) hold several days' supply, (2) provide a constantly available supply, (3) prevent waste, and (4) be sanitary.

Large reservoir-type self-feeding hoppers are not successful. Open-trough feeders are coming more and more into general use and are quite satisfactory, since the mash is easily obtained by the birds and is not wasted when the feeder is filled properly. Such feeders increase mash consumption, ensure a constant supply of mash, and keep the feed clean of droppings. They should be filled to within 2 or 3 inches of the top (B of Fig. 45).

At least one foot of feeding space for mash and another foot for grain, if hopper fed, is required for each 4 hens.

Automatic feeders which carry mash to the pens by means of chains moving within a trough are quite expensive, but are rapidly coming into general use for large flocks (A of Fig. 55).



FIG. 53. The completed nesting room 8' X 7' with two units three nests high. Note the sliding entrance door which can be raised or lowered from inside. Note also the opening on two sides at the ceiling, providing air circulation.

Grit and shell containers are necessary. For small flocks, these may be small hoppers hung on nails against the wall. For large flocks, the space between the studding can be used most effectively and economically by boarding from stud to stud to form the front and bottom of a hopper (Fig. 39). Provide 4 feet of feeding space for shell and 1 foot for grit to each 100 layers.

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FIG. 54. Inside of the nesting room. Trough sides are 8" high, thus permitting ample nesting material.

Storage bins. One is needed for mash and one for grain, and each should hold feed enough to last at least 1 week. Storage may be in bins on each floor, in bags on racks, or in large storage bins on an upper floor from which the feed is lowered in chutes (Fig. 80).

For small flocks, heavy barrels or ash cans with covers serve the purpose satisfactorily. Keep bins where the birds cannot get on them.

The water supply is most important, requiring more labor on many farms than any other item. A poor system quickly cuts production. When not properly controlled, it causes wet litter for a considerable distance around and away from the water receptacle, adds to the filth, and may increase the number of dirty eggs and parasites.

The water supply should be (a) adequate (more than one supply source is desirable), (b) clean, (c) cooled in summer by protection from the sun, (d) arranged to catch and eliminate waste water, (e) proof against freezing.

From 6 to 7 gallons of water are needed daily per 100 layers, or about $\frac{1}{2}$ pint per bird.

An automatic supply is most satisfactory in terms of the labor involved. Small automatic fountains or basins, 4 to 6 inches in diameter, will accommodate 100 to 200 layers (Figs. 59 and 60). One pan 18 inches in diameter and 4 to 7 inches deep will care for 300 layers, with either running water or float valve installation, and is best arranged with an overflow device for protection (Figs. 57 and 58).



A



B

FIG. 55. A. Laying pullets feeding as a chain carries mash along from an automatic feeder. Six birds to 1 linear foot of hopper provides sufficient room. B. Laying pullets feeding from an open box into which 100 lb. of mash has been emptied.

layers. The length of trough needed is determined by width, height, number of birds, and gallons of water required.

For example, if the trough is 12 inches wide and 7 inches deep, what length is needed for 100 layers?

$$7 \text{ gal.} \times 231 \text{ cu. in. water per gal.} = 1617 \text{ cu. in. water needed}$$

$$12 \times 7 \times 1 \text{ in.} = 84 \text{ cu. in. per in. of trough}$$

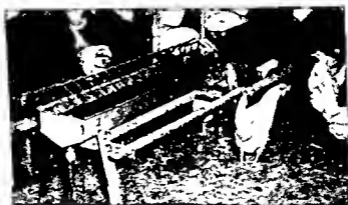
$$1617 \div 84 = 19.25 \text{ in. or } 1.64 \text{ ft. of trough required}$$

To prevent litter being thrown into the drinking water, elevate the receptacles at least 1 foot above the litter.

Waste water results from overflow or cleaning, dripping beaks and wattles, and water thrown as birds shake their heads. A



A



B

FIG. 56. A. V-shaped water trough. B. Metal trough 8' \times 10' \times 6" for 300 hens, soil heating cable on pipe. Both have many advantages, and the disadvantage of a wet floor. Cornell University.

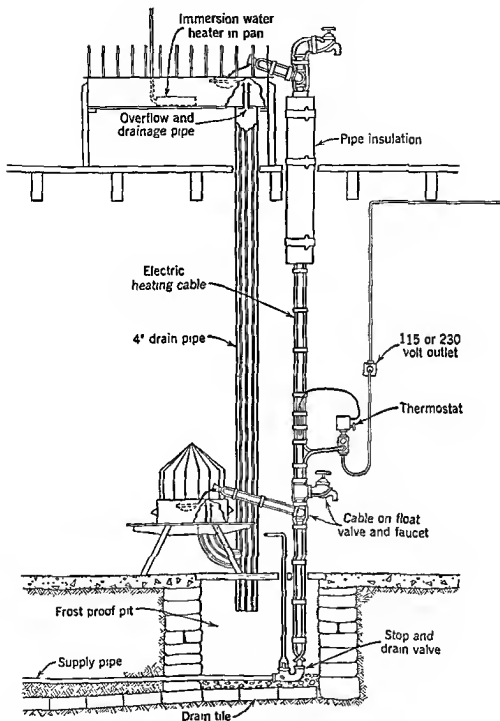


FIG. 57. Heating-cable installation and drainage system Courtesy Cornell University.

waste-water pipe leading outside directly or into a dry well connected by tile to the outside or to a cesspool or sump takes the overflow and is practically essential in large flocks (Fig. 57).



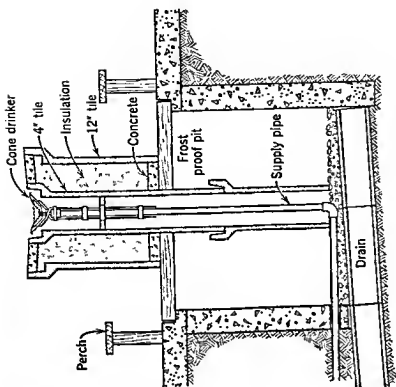
FIG. 58. Automatic water supply for 250 to 300 layers. *a*, planks covering a pit which is connected by a drainpipe to the outside; *b*, concrete floor; *c*, drainpipe which carries waste water into the pit; *d*, short overflow pipe which screws into the bottom of the 15" diameter drinking pan. To clean the water dish *d* is unscrewed. Note the float valve at end of water pipe.

Size of pipe and installation. The dry or waste well may be 2 to 2½ feet deep to avoid freezing and for easy cleaning. It may be fitted with a plank cover (Fig. 57 and *B* of Fig. 59). Galvanized water supply pipe or copper tubing ½ to 1 inch in diameter is satisfactory both within the house and for carrying water to a house several feet away. Less friction results with the larger sizes. To avoid freezing, outside pipes should be buried 4 to 4½ feet, and those under floors 1 to 2 feet. Latitude should govern depth.

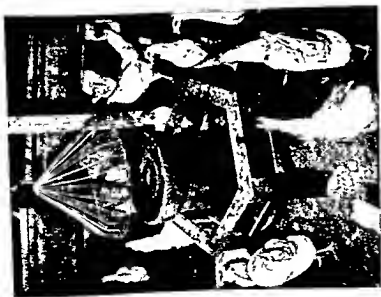
Freezing is reduced or prevented by insulated houses, stop and drain valves, running water, automatic water warmers, and electric soil heating cable.

*Electric heating cable for poultry watering systems.** A lead-covered heating cable which was developed for heating soil for plants in hotbeds is being used by poultrymen to protect water supply pipes from freezing. The cable is flexible and waterproof so that it can be attached to all parts

* From Professor C. N. Turner, Department of Agricultural Engineering, Cornell University.



B



A

FIG. 59. A. Automatic waterer which eliminates wet floors from that source. Discarded grill with poultry netting, hung 6" to 7" above waterer, reduces waterthrowing. B. Diagram of a cone drinker. 12" tile outside rests on floor. 4" bell tile inside extends into drainpipe below floor level. $\frac{1}{2}$ " of cement between the tiles at top slopes toward center tile. Space between tiles filled with insulation material. $\frac{1}{2}$ " of cement at top slopes toward center tile. Water pipe is at center of 4" tile, with waterer at top. Waste water flows down inside of 4" tile. Heating cable may be used on the water pipe in cold climates.



FIG. 60. Five waterers served 950 layers. The built-up litter was in excellent condition through the winter, and the water supply appeared adequate. No trouble from worms or other parasites was evident.

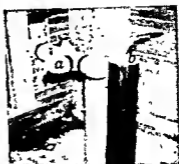


FIG. 61. Water pipe protected with heating cable and covered with air cell insulation. *a*, A protected faucet; *b*, handle which operates an underground shutoff. The rod extends to the shutoff through a length of tile. The shutoff is a precaution in cold weather against the possible accidental loss of electric current.

of the supply system. A thermostat turns on the electricity when the temperature of the pipe approaches the freezing temperature of water.

Since the cable carries only one electric heating wire, either the cable or a single conductor copper wire must be used for a return conductor to complete the circuit. Therefore, two strands of the cable are usually installed along the pipe, making a loop to complete the circuit. Whether a single or double strand of cable is used along the pipe depends upon the length of the pipe in relation to the length of cable and the amount of heat needed.

The cable can be installed to operate on 115 or 230 volts. Sixty feet of cable operating on 115 volts supplies 400 watts of heat, and 120 feet of cable operating on 230 volts supplies 800 watts of heat. Shorter lengths of cable for each voltage must not be used because it will operate at too high a temperature. Longer lengths can be used for each voltage, but the number of watts of heat will be correspondingly reduced. Several lengths of cable and the wattage produced on 115 or 230 volts are shown below.

Wattage of Different Lengths of Cable

Cable Length, feet	Circuit Volts	Total Watts	Watts per Foot
60	115	400	6 $\frac{2}{3}$
75	115	320	4 $\frac{1}{3}$
90	115	260	3
120	115	200	1 $\frac{2}{3}$
120	230	800	6 $\frac{2}{3}$
150	230	640	4 $\frac{1}{3}$
180	230	520	3
240	230	400	1 $\frac{2}{3}$



FIG. 62. A water system protected by heating cable. *a*, Air cell insulation which surrounds the water pipe and cable; *b*, the thermostat which is connected with *c*, the electric convenience outlet; *d*, 4" tile serving as drains for waterers on the floor above.

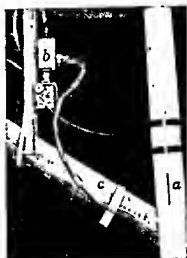


FIG. 63. The thermostat connected by a small wire to the expansion bulb lying against the pipe and exposed to the air by a slit, *a*, in the air cell insulation; *b*, the part of the thermostat to which the heating cable is connected; *c*, drain for the waterer on the floor above. Small thermostats about 1" by 4", placed directly against the water pipe, are more easily regulated and apparently as accurate as *b*.

Elevator. In multiple-story poultry buildings, feed, litter, crates of birds, and miscellaneous items must be moved to various floors. A chain hoist, belt, or platform elevator appears indispensable (Fig. 82). Check your state laws governing elevators in farm buildings.

The type may depend on the size and kind of load and the height lifted. Locate the elevator where most labor can be saved in servicing from it and where there is no interference with large-scale cleaning or other work.

A platform 3 by 4 feet will hold crates of birds or a bale of litter.

Caution against expensive appliances. There are on the market a great many utensils and fixtures. Some of these have considerable value, and some are impractical or too expensive. Often fixtures may be constructed at the plant at much less cost. Care must be taken not to add to the investment more than is necessary for conducting a profitable business. The fixtures should not be elaborate, and should be designed to save labor and to be sanitary, serviceable, and practicable.

Laying cages. Each hen is kept in an individual cage or compartment about 8 to 12 by 18, by 17 inches high. Formerly cages were built in batteries 18 to 24 cages long and 3 to 4 cages high. Today there appears to be a swing toward single-deck cages and a trend toward fewer cages in the colder areas and more in the warmer. There is still a question whether the advantages can overcome the disadvantages and thus bring the batteries into more permanent use. In colder climates they appear best adapted to restricted communities, such as those in or near cities where land is high in price and select retail trade is possible. Laying battery rooms may be constructed in barns, stables, or other outbuildings or in any unused rooms. If battery rearing is practiced, less land is required than for rearing on range.

The need for nests, feed hoppers, droppings boards, and litter is eliminated. The vice of cannibalism among birds is not a problem. Egg records can easily be kept on individuals. Thus the laying cages have value in providing the opportunity to learn the quality of birds individually. It is probable that the skill of the poultryman in observation and in physical examination of the birds will accomplish culling in a floor flock at less cost. Just when cage birds should be culled is still questionable.

Overhead costs involved in more expensive buildings, especially in the Northern States, and in the batteries place a greater financial

burden on the business. Special ventilation in rooms accommodating several hundred birds is required. The rooms must be warmed in cold weather to 40 to 45 degrees F. and must be insulated to conserve heat in winter and keep the birds cool in summer. The usual method is to move the air with electrically operated fans located in walls or shafts, and construct insulated double walls and air intakes. In such construction the air may become too dry for poultry.

McNiece,* after a study of laying cages in many sections of the United States and in Hawaii, arrives at the following conclusions.

The cage system has grown to its present size primarily as a result of promotion rather than because its use is based on research data.

Single-deck laying cages cannot be considered a fad like the multiple-deck cages. The single-deck cages will probably be used successfully in many areas, but it is very doubtful that they will replace floor-type management altogether.

Laying cages are just another management system. The use of laying cages will not, in itself, assure greater profit than will floor-type management; it all goes back to the man and his management.

Community Survey

1. Ask a carpenter to show you how to mark out rafters with a steel square. Record each detail, then practice for several roof slopes.

2. What determines the time of year, among local poultrymen, when pullets are placed in permanent laying quarters?

3. Ask several poultrymen what cleaning or other preparation they give the buildings before pullets are placed in laying quarters.

4. When a poultry house is being constructed in your locality visit it each day, if possible, and note the order in which the carpenter proceeds.

(a) When are the sills put in place?

(b) When are the corner posts and studs erected?

(c) When and how is the floor laid?

(d) When is the roof constructed?

(e) When is the siding put on?

(f) At what point in the construction are the windows, ventilators, and other openings finished?

5. Visit several poultry houses and obtain the following information in regard to each:

(a) Perches: Amount of perch space per hen. Size of perches. How are the perches supported? Where are the perches located in the house?

* D. McNiece, "Laying Cages," *Stencil 211*, Cornell University, Ithaca, N. Y., 1935.

(b) *Droppings*: Where do night droppings fall? Why has the poultryman decided on this method? Could labor in cleaning be saved by using another method? Why or why not?

(c) *Nests*: What has governed the location of the nests? Can the location be improved to save labor? If so, where and how might this be done? What is the ratio of nests to hens? Is this sufficient? What is the poultryman's reason for using or not using nest partitions?

(d) *Broody space*: How are broody hens broken up?

(e) *Feeders*: What type is used? Where placed? What size are they and how many hens do they accommodate? From where are the feeders serviced? How is feed stored until used in the feeders?

(f) *Water receptacles*: What type of watering equipment is used? Are any of the buildings supplied with an automatic water supply? Sketch the system, if satisfactory, in one house, showing how water is supplied, waste cared for, and freezing prevented.

(g) *Elevator*: How is it serving a useful purpose?

(h) *Track and car*: Estimate the amount of time saved by using this equipment. Is the expense justified?

6. Visit a laying battery plant if possible. How many more birds can the poultryman keep by the battery method? Are there any empty cages? Is the house more expensive than the usual laying house? How much more per bird? Is more or less labor required for a similar number of birds?

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Write your own state college for bulletins and plans on housing poultry recommended for your state.

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Principles of Housing Poultry

General information:

1. Why we house poultry.
2. The hen home.
3. The necessity for pure air.
4. Temperature.
5. Air movement.
6. Siding and walls.
7. Moisture.
8. Compost or reused litter.
9. Ventilation.
10. Direct sunshine.
11. Size of flock.
12. The comparative merits of types of roofs for laying houses.
13. Roofing material.
14. Foundation.
15. Floor.
16. Front.

1. Why we house poultry

We often hear it said that we cannot improve on nature. From nature's standpoint we probably cannot; but from the human business point of view and for the purpose we have in mind, we often can improve on nature.

For example, nature's object, with poultry, is to cause the hen to reproduce herself and maintain the race to which she belongs. In accomplishing this, the hen is required, under natural conditions, to live an exceptionally healthy and vigorous life, as only by so doing can she produce offspring possessed of the qualities necessary for existence in the wild state.

The hen in her natural or wild state is required to lay but very few eggs, and these only in the spring of the year. She maintains her vigor by roosting where there is an abundance of pure air, and where conditions are such that only the birds endowed with the

greatest amount of vitality survive. Although the bird that survives is very high in vigor, she loses decidedly in egg production by being exposed to severe climatic conditions and because there is no need to produce eggs and attempt to rear chicks during seasons of natural food shortage and severe weather.

The modern business hen is required to lay many eggs, and the effort to make her do so frequently results in a weakened and pampered hen, from nature's standpoint. The natural vigor of the hen is likely to be sacrificed somewhat, in the effort to secure heavier production, unless special precautions are taken to safe-



FIG 64. Laying houses across the nation. Typical Maine laying house, used as a brooder house at certain times of the year. This practice is frequently found in Maine. Courtesy University of Maine.

guard her health by methods of feeding and management. Other things being equal, the higher producing bird is by nature the more vigorous one, and is the better layer and the better breeder.

It is necessary to provide a comfortable poultry house in order to secure a satisfactory yearly distribution of egg production. The real problem in poultry housing is to determine how to balance the conditions that make for nature's method of maintaining health and vigor, and the conditions that produce man's commercially profitable hen.

2. The hen home

The best egg production is secured from birds that are comfortable and happy. The meaning of comfort to the hen carries with it all the factors which make the ideal environment. Environment includes all phases of management that have to do with the care of the hen.

To a large extent, the comfort of the hen is directly dependent upon the kind of house she occupies. A major part of her time is spent there and it is there that she receives most care. The word "home" usually suggests "comfort." The hen home should be a

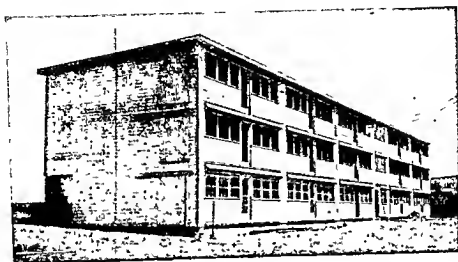


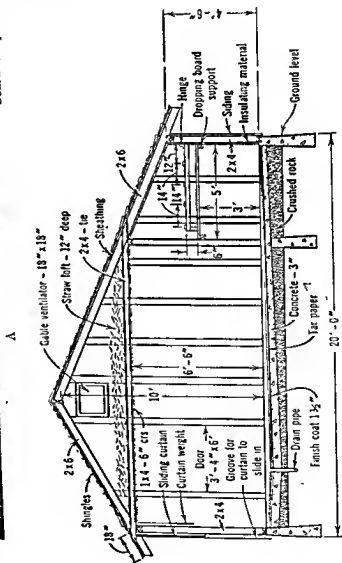
FIG. 65. Laying houses across the nation. A flat-roof multiple-story poultry house in Connecticut. The roof is "built-up." The walls are well insulated. The outtake is at the top of the windows. The intake moves air up between the outside and inside walls and into the house just below the windows. Courtesy University of Connecticut.



FIG. 66. Laying houses across the nation. Minnesota; a practical two-story house for a commercial flock. Courtesy University of Minnesota.

FIG. 67. Laying houses across the nation
A. Colorado, shed-roof commercial laying house 21' wide, for 500 hens. The high front openings are equipped with sliding muslin curtains, which when closed leave an air exit above and an air intake below each curtain. A baffle board is placed at the intakes. See

Fig. 75. Courtesy Colorado State College. B. Montana, 20' X 20' unit, combination roof, straw-loft type house with high sliding front curtains. Courtesy Montana State College.





A



B

FIG. 68. Laying houses across the nation. A. 20' \times 20' straw-loft two-unit house for 200 hens, used in Illinois. Straw affords low-cost insulation and helps maintain moderate and fairly uniform temperature. Courtesy University of Illinois. B. 20' \times 70' straw-loft house with 10' feed room, the desirable 300-hen unit on Kansas farms. The house provides protection from strong winds, blowing rain or snow, and intense heat and cold. One square foot of open front with sliding muslin curtain to each 10 to 12 square feet of floor space is allowed. Courtesy Kansas State College of Agriculture and Applied Science.

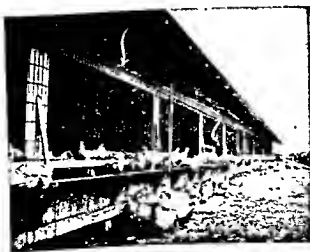


FIG. 69. Laying houses across the nation. A type of front in Washington. Note the rolled curtain, which may be dropped if desired.

place of comfort, safety, contentment, cheerfulness, and happiness. Given these, the hen responds. The man who provides them shows that he recognizes the fundamentals of egg production. Egg production is based on a contented mind, and not merely on a satisfied stomach.

We should think, then, in terms of a "hen home," rather than a "hen house." There is too often a vast difference between the two. The home we construct is to be rented to the birds. Our rent must be paid in eggs if it is paid at all, and it will bring revenue according to the way it provides comfort for the birds. The hen's attitude toward her surroundings will go far in egg production. The hen does not "will" to lay, nor a seed to germinate, but if given the proper environment, both will respond.

3. The necessity for pure air

Perhaps the most important factor in securing comfort for the birds is an ample supply of pure air. When the amount of pure air is limited, a loss in vigor results. Protection from wind and storm is necessary, but a constant supply of pure air is absolutely essential for continued vigor. The hen breathes very rapidly, thus using much more air in proportion to her size than other domestic animals. King gives the following figures on the amount of air per 1000 pounds live weight each 24 hours.

Cow	2804 cubic feet
Horse	3401 cubic feet
Hen	8278 cubic feet

As a disease preventive, a health promoter, and a factor in good production, pure air stands high in importance. Nothing used by poultrymen in the attempt to secure good production is cheaper.

4. Temperature

Birds should be kept comfortable in the sense that they are protected from extreme cold and wind in winter and extreme heat in summer. Either extreme tends to retard production. While birds undoubtedly would be benefited if the temperature were not allowed to go below zero or even below freezing, provided the supply of pure air were not diminished, there are no figures available in connection with any present methods of applying heat that show a profitable increased production as a direct result.

The most practical method yet devised to keep the temperature

from falling much below freezing and the supply of fresh air in no sense reduced is to construct insulated walls. Proper house insulation and ventilation also largely reduce the difficulty from summer heat.

It has been found that temperatures above 10 degrees F. in the Cornell 20 by 20-foot poultry house do not affect production, and that temperatures below 10 degrees F. cause comb frosting and may temporarily affect the production of the flock. However, no serious ill effects from low temperatures were experienced in the experimental poultry houses at Cornell over a period of 7 years when provision was made for the elimination of the warm moist air given off by the birds.

5. Air movement

Air flow, or movement of air through the pen, is a most important factor. It is caused by the heat given off by the birds, and is affected by the wind.

Vertical air movement. The warmth inside the house causes the air to expand, become lighter, and hold more moisture. This lighter air is urged upward by the incoming air, which is colder and which pushes underneath. Thus an air movement is set up.

During the day, when the birds are on the floor, the heat from their bodies is fairly well distributed over the area. The air that comes in through the intakes passes down to the floor and up to the ceiling as it becomes warmed. When the birds are on the perches, the air that enters falls to the floor and moves across the floor to the perches, where the air near the birds' bodies is lighter. It then passes to the ceiling. In so doing, it picks up the moisture in the air and should move on outside before it cools and the moisture is released. As air cools, it loses its ability to hold moisture.

Along with the vertical air movement just described, there is another important movement. This is *horizontal air movement* caused by wind entering at one end and going out the other. A



FIG. 70. A small shed-roof house, facing south; prevailing winds from N. W. Note the circulation which takes place within the house. The air is drawn out at the S. W. corner and in at the S. E. corner. This building was used several winters with the upper windows entirely out. The production was excellent and colds among the birds unknown.

Practical Poultry Management

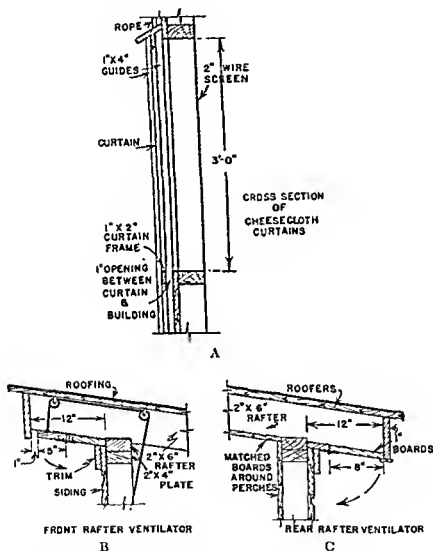


FIG. 71. Rafter ventilation, construction of ventilator doors and curtains. A. The curtain is set away from the house 1", leaving a 1" opening at the bottom for an air intake in a tightly constructed house. B. The front ventilator door should be open in summer in a small house, but in winter it may be closed, as the 1" opening provides sufficient outtake. Houses larger than 20' X 20' should have a 2" opening, which permits the ventilator to be constantly closed. C. The rear ventilator door should be closed in winter and opened in summer. Cornell University.

long, narrow house provides a tunnel for the wind to race through. Large, deep houses reduce this somewhat. Curtains or windows on the windward end, where air is entering, should be closed at such times. (See Figs. 70 and 72.)

6. Siding and walls

A tightly constructed wall is desirable in the northern section of this country to protect the birds from strong prevailing winds. Whether the wall should be of the simple or low-insulation type or well insulated will depend on the interior house condition desired and the cost involved. Also the type of air movement or ventilation is dependent upon the wall construction.

Walls of low insulation are in most common use today. They cost less, but the interior is colder and more susceptible to outside temperature changes. Air should move through such houses steadily and without coming to rest against walls or ceiling long enough to permit cooling of air and condensation of moisture. The air outlet should open at the ceiling, if flat, across the front by the so-called rafter or slot method. The flue system, although more expensive, is used. A house of the shed type should have the outlet at the high point.

A layer of boards of good-quality yellow pine, fir, hemlock, or spruce, well laid, covered on the outside with building paper, and finally clapboards or other siding makes a satisfactory and protected wall. Paper should not be placed on the inside, exposed to the birds, as it may be torn.

Insulated walls are used where a more uniform and warmer interior is desired. They are more expensive. In such houses the air movement may be less rapid and the change of air slower. The air outlet may be through restricted front ceiling or rafter openings, or through flues opening within 18 inches of the floor (Fig. 74).

Fowls will destroy certain types of insulation board. When used on the inside, such boards may be protected by covering the area for $2\frac{1}{2}$ feet with metal or fine mesh wire.



FIG. 72. Rafter ventilation on this two-story flat-ceiling laying house. Note 2" opening full length at outer edge of overhang on both floors.

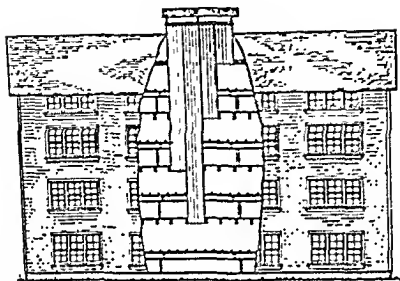


FIG. 73. The ceiling outtake-flue system of ventilation for a cold or uninsulated walled house. Each floor has a separate flue. From *Cornell Ext. Bull.* 315.

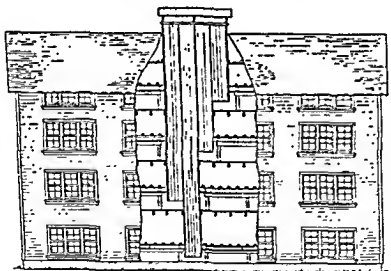
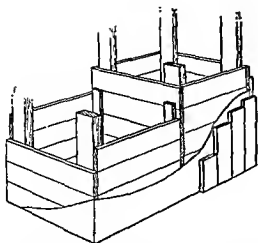
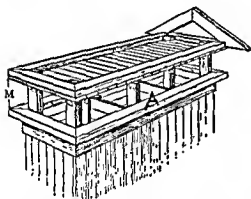


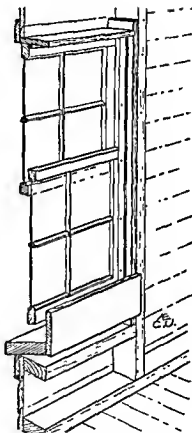
FIG. 74. The floor outtake-flue system of ventilation for warm or well insulated poultry houses. A 4" wall filled with wood shavings gives good insulation. In both ceiling and floor outtake flues, 1 sq ft of opening is required for each 300 sq. ft of floor space. From *Cornell Ext. Bull.* 315.



The outside of the flues, whether one flue or several, is of two layers of boards with paper between. The common side between flues is of one layer of boards. Note construction of the second (left) flue against the first.



The ventilator head consists of the ceiling and the roof. The ceiling may be insulated with several inches of shavings before the gable roof is completed. The bottom of the opening *A* should be at least 2' above the ridge of the roof. From *Cornell Ext. Bull.* 315.



Window intake for use with the flue outtake. In a well insulated house an equal number of square inches are needed in both intake and outtake.

FIG. 75. Constructing the flue and window intake.

Siding should be thoroughly dry when it is put on; otherwise cracks are likely to open up between the boards when wind and sun have dried them out.

7. Moisture

In itself, moisture is not harmful to adult chickens. It is a warning to the operator that ventilation, and hence pure air, may be inadequate or that there is excessive spillage at the drinking utensils. The one affects the vigor of the birds; the other may increase dirty eggs, rot wooden floors, and generally make an unsightly, smelly house with possible danger of disease or worms (page 287). When compost litter is used, dryness may become quite important in preventing worm infestation. A large amount of moisture is expelled from a hen's body through voidings and breath, because of her large consumption of water and rapid breathing. From these two sources, assuming no excess water is thrown from the water receptacles, the air becomes quickly saturated if the house is improperly ventilated.

The condition of the litter and the temperature of the air in the house determine the rate of evaporation of moisture. The ventilation system is called upon to remove it, but it cannot remove excess spillage from water receptacles.

8. Compost or reused litter

The use of compost litter (see pages 45 and 49) for hens is not new. Often, when poultrymen are asked how frequently the litter is changed in their laying houses, the answers vary from 5 to 10 years. This practice has not been publicized by the poultrymen for fear their methods would be considered unsanitary. Professor D. C. Kennard, of the Ohio Agricultural Experiment Station, is given credit for first reporting several years of experiments with compost litter. Certain poultry pathologists who have worked with compost litter say that compost litter gives excellent results in controlled experiments.

There are limitations, but the fact remains that poultry diseases experienced today do not appear to be confined to any one type of management. Older birds as well as chicks are almost constantly picking up small particles from the litter, the floor, the ground, or from manure piles (when given the opportunity). Much picked up from the litter is dried droppings. Even when fed free-choice grain and mash in hoppers, chickens spend much time scratching

and picking up and eating particles from the litter. There are nutrients in dried droppings, such as vitamin B₁₂ and riboflavin. When grain is fed in dry litter, poultrymen think little of harmful results regardless of the age of the litter.

The fine particles of compost litter, having far greater absorptive and evaporative power than new litter, dry out and cover fresh droppings much faster.

It is difficult to find anything basically wrong with compost litter when its use for several years is accompanied by good management, i.e., proper ventilation, dry condition around waterers, reduced spillage, and occasional removal of the top inch of packed-down litter around water receptacles.

If management is right and bacterial diseases such as cholera or typhoid, virus diseases such as Newcastle or bronchitis, and internal parasites are not present, to infect the birds these must be brought in from the outside. Whether the litter is new, built-up, or compost matters not, if the diseases find their way in. *Preventing their entry is the important thing.* The use of compost litter appears safe on a poultry farm operated by a poultryman who understands desirable management of chickens and practices it. All others beware.

9. Ventilation

In addition to the rafter and flue methods of ventilation, the electric fan is being successfully used. The fan must move 1 cubic foot of air per minute per bird.

The amount of air that a fan can move depends upon the diameter of the fan, the shape and the angle of blades, and the speed of the motor. For that reason, the diameter of the fan alone is not much indication of the amount of air it can move. Each company manufacturing fans rates its own product for air movement and for the amount of power needed for the amount of air moved.*

The fan is mounted in an opening the diameter of the fan blades, and an air duct of insulating board is constructed (Fig. 76). The opening at the base of the air duct should be just double the area of the fan opening. A service door is located near the top. Inlets are needed, 60 square inches for each 250 square feet of floor space, placed about the pen. None should be less than 8 feet from the air duct. Quoting again from Professor Hoff:

* From article by Professor Paul R. Hoff, Department of Agricultural Engineering, Cornell University.

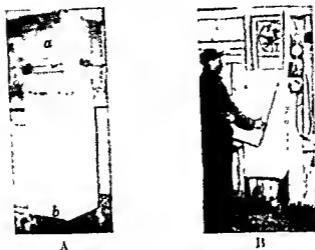


FIG. 76. A. Outtake fan installed in sidewall near ceiling, with short duct extending to within 20" of the floor. B. Cover is removed from opening behind the fan for oiling, cleaning, or taking air from the pen at ceiling level in warm weather.

RELATION OF FAN AND INTAKE OPENINGS TO FLOOR AREA

Floor Area, sq. ft.	Size of Duct, in.	Approximate Diameter of Fan, in.	Number of Intakes, 60 sq. in.
400	12 X 12	9 or 10	2
800	12 X 12	9 or 10	3
1200	12 X 15	12	5
1800	15 X 15	12	7
2700	18 X 18	14	11

Courtesy Prof. C. N. Turner, Cornell University.

The fan should be attached to a capacitor (or a split phase) motor, totally enclosed and with sleeve and thrust bearings. The motor should have a large capacity lubrication system so that it can be lubricated once each season and it will run through without further attention.

Some type of overload protector should be in the circuit so that the motor will not burn out due to stopping when the current is on. Excessive back pressure caused by a high wind blowing against the outside wall where the fan is located, or stopping of the motor when an object is drawn into the blades causes overloading of the motor and may cause the motor to burn out unless it is protected by a device that cuts off the current in such an emergency. The most easily installed protection is a delayed action fuse of the right size for the motor. This type of fuse can be put into any fused switch.

An open end motor of the variety commonly used for small appliances, and without overload protection, is a fire hazard and should not be used for fan operation in a poultry house.

10. Direct sunshine

Sunlight is important for hens and for chicks. It contains beneficial ultraviolet rays which help them utilize calcium, build better bones and egg shells, and maintain the proper balance of calcium and phosphorus in the blood. Poultry enjoy it. Its absence in the past brought harm to chicks, such as rickets. Curtain- or glass-front houses, correctly operated, make use of this cheap and usually abundant factor. Today, however, feeding oil in our rations has prevented deficiencies resulting from sunlight entering the house through glass and not direct, and poultrymen are no longer dependent upon it. Proper rations protect chicks from the lack of these direct rays of sunshine through the brooding stage and through life. It is well to keep houses open when weather permits if rearing in confinement. While on range, the poultry take full advantage of the sun.

Exposure. East or southeast, south, southwest, and west are the desirable exposures in their usual order of preference. If winds and storms are common from the south, the house should face east or in one of the other directions where the least interference with air movement within the house may be expected.

11. Size of flock

Small flocks usually increase the cost of labor, equipment, and buildings. They are adapted to side-line poultry keeping or to poultry breeding farms. Larger flocks are more often found on commercial egg farms or ranches. Units of 500 to 1000 hens per flock are common, and larger units may be successfully handled.

Commercial laying flocks are kept in confinement through the laying year.

Floor space. The smaller the flock, the more floor space is required per hen. Ten hens might need 6 to 8 square feet per bird. Leghorn hens may be kept profitably in flocks of 100 or more with an allowance of 3.2 square feet per hen. For heavier varieties, 4 square feet per bird is the usual figure. It is always well not to overcrowd.

Air space. Experiments at the Wye (England) Agricultural College indicate that about 40 cubic feet of air is necessary per hen per hour. These experiments showed that a pen could be constructed in which the air would change four times per hour, and led to the conclusion that 10 cubic feet of air space per pound live weight is sufficient.

It is difficult to construct a large house and have much less than 15 to 20 cubic feet of air space per hen in the pen, unless the floor space per bird is greatly reduced, or the ceiling is so low that the attendant cannot work to advantage. Either fault would show disappointing results. We may conclude, therefore, that the air space will be sufficient if the pen is made as low as is commensurate with the height of the person who is to do the interior work.

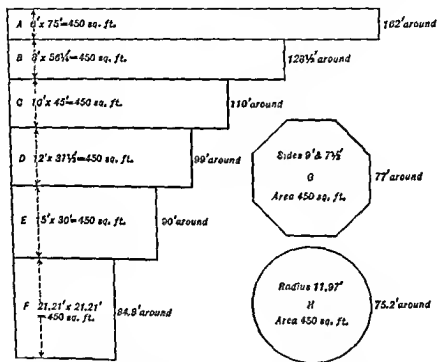


FIG. 77. Comparison of distance around a given area.

Shape. A study of Fig. 77 will show that the distance around a given area is less in a round poultry house than in one of any other shape. The expense of construction makes the round or octagonal house impractical. Of the other types, the more nearly square the house is, the less material is required to construct it and the cheaper will be the cost per hen.

Depth. The deep house has advantages over the narrow one. It is likely to be cheaper in construction and more easily equipped to save labor. Modern multiple-story houses, ventilation, insulation, and feeding make the house 30 or more feet in depth practical, where formerly it was seldom used. Depth is governed by the purpose for which the house is to be used, whether new construction

is necessary or existing buildings are to be made over, by the cost, the possible future use, the location, and the height.

A breeding farm doing individual pedigree or progeny testing work may find the longer, relatively narrow house more easily made into pens. Pens can be constructed in larger houses, however. Laying units of 100 to 125 are economically housed in 20 by 20-foot pens. Five hundred layers do well in a 20-foot house 80 feet long, or in a 30-foot house 50 to 65 feet long, depending on the variety. Still larger flocks are commonly found in houses 40 to 60 feet wide.

Lumber may cut with less waste for one depth of house than for another. Type of roof governs the efficiency of wide houses.

12. Comparative merit of types of roofs for laying houses

Monitor. The full monitor dates back to the time when a tight single-story house, with sunlight reaching all parts, was thought to be ideal. It is not a practical laying-house roof. Such a building may be remodeled.

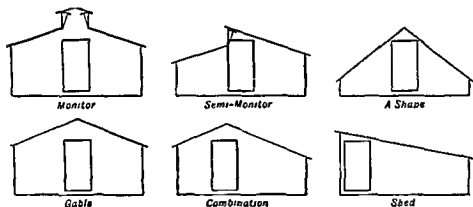


FIG. 78. Types of roofs.

Semimonitor. One of the original open-front houses, it was first used about 1900. It helped focus attention on the value of fresh air for poultry while retaining supposed desirable features of the monitor. It is not a practical laying-house roof.

A-shaped. This is usually built with sides from $1\frac{1}{2}$ to 2 feet high. It covers a given floor space at reasonable expense. Head-room is lacking, and light is unevenly distributed over the floor. One house seldom accommodates over 150 adult birds.

Gable, or even span. A house with this roof has too much air space for comfort. It can be ceiled 7'-8' above the floor, flat, with

$\frac{7}{8}$ -inch insulation board, using rafter or slot ventilation across the front or a flue if preferred. Often it can be improved by installing a straw loft. Either results in a cooler house in summer and a better protected pen in winter.

To construct a *straw loft*, lay poles from plate to plate or across the building at least 7 feet above the floor, and place boards on the poles, 1 or 2 inches apart. Two feet of straw should be placed on the boards, pressed firmly around the sides, and the rest allowed to be rather loose. A window or opening is cut in each gable, and air circulates above the straw. The warm, moist air from the room below works slowly through the straw, which absorbs the moisture, while the circulation above dries the straw and removes the foul air. This method of ventilation provides an abundance of constantly changing air.

Old sheds and buildings may be remodeled into comfortable laying houses by constructing a straw loft.

Gable roof construction is expensive, and front eaves troughs are required to avoid muddy conditions on certain types of soil. The straw is dusty and a possible breeding place for vermin.

A combination roof has one-third of the roof toward the front and two thirds toward the rear. On a deep house it cuts down the air space by eliminating the high peak in front, but it is likely to cause trouble by the banking of air at the peak and the condensation of moisture there. Putting ventilators at the peak or boarding across the peak, sloping from a point on the rear rafters 6 to 7 feet above the floor to the front plate and using the rafter outlet, may eliminate the trouble.

Shed roofs are widely used and are becoming more popular on deep houses. A very low pitch is possible, a rise of 1 foot in a run of 5 to 10 feet on houses 20 feet deep, or 1 foot in a run of 15 feet on houses up to 60 feet deep, using either a 19-inch overlap roll roofing or a built-up type of roofing material. Height of rear wall, type of roofing, room to work, depth of house, and height in front are factors to consider.

Flat. The flat roof may assume greater popularity in poultry house construction. It reduces the air space and siding required. It is well adapted to the rafter, flue, or fan method of ventilation, and to built-up roofing (page 97).

13. Roofing material

Roll roofing is usually comparatively low in price and easily and quickly laid and repaired. It should be laid on a day when the sun will soften the tar in the paper and thus cause it to lie flat and bend without cracking.

Shingles require a steeper roof than roll roofing and should not be used for a shed roof.

Metol roofing may be used above roof insulation or when an air space is provided between the roof and the room below.

An excellent material for roofs, particularly those having little slope (low pitch), is *19-inch overlap roll roofing*. This differs from ordinary roll roofing in that the wide selvage, 19 inches instead of 2 inches, makes each strip overlap 19 inches, eliminating exposed nails, the danger of water seeping through at the seams, and wind damage. The selvage of each strip is nailed to the roofing boards and given a coat of asphalt cement before the next layer or strip is put on. All nails are therefore covered, and the lower half of the strip is held in place by the asphalt cement. Detailed instructions for applying this type of roofing material are always supplied by the manufacturer.

Built-up roofing is very satisfactory for relatively flat roofs. For this type of roofing, a layer of light roofing paper or slater's felt is applied to the roof boards in the same manner as ordinary roll roofing, except that the entire surface, including the seams, is nailed securely to the boards. A double layer of slater's or asphalt felt is then cemented to this base, using either prepared or hot asphalt. Each strip of this double layer is overlapped a little more than half of its width on the strip below. No nails are used except those securing the felt to the four edges of the roof. This type of roofing has the same desirable features as the 19-inch overlap. It is somewhat more expensive to install, but can be maintained indefinitely by applying a coat of asphalt when needed.

14. Foundation

The foundation walls should be (1) deep enough to prevent heaving by frost, (2) well drained, (3) heavy enough to support the building, (4) economical, (5) ratproof.

Concrete. See Chapter 4 for details of constructing a concrete foundation. Concrete has no particular disadvantage. A 1:2½:5 mixture is desirable. This means 1 part of cement, 2½ parts of

sand, and 5 parts of crushed stone or coarse gravel. In figuring the amount of these ingredients, the following example will prove helpful.

EXAMPLE

Given a wall 10 by 3 by 1 foot.

Total space to be filled, 30 cubic feet, = the amount of coarse gravel or crushed stone required.

Mixture used, 1:2½:5.

$\frac{2\frac{1}{2}}{3}$ or $\frac{1}{2}$ of 30 cubic feet = 15 cubic feet sand required.

$\frac{1}{5}$ of 30 cubic feet = 6 cubic feet cement required.

A bag of cement holds about 1 cubic foot.

Posts. Wood posts are being used in semipermanent foundations, after soaking in preservative. The pole house finds many uses.

Cinder blocks 8 by 8 by 16 inches may be used as posts above-ground.

Concrete posts are satisfactory either below or above the ground.

15. Floor

A desirable floor should be moistureproof, ratproof, durable, economical, smooth for cleaning, sanitary, and comfortable for the birds.

Earth. It is impossible to secure all these essentials with an earth floor. There are times when the type of soil, the location of the house, and the first low cost make the earth floor desirable for a year or two.

Board. Floors above the first floor are most often of wood. The first floor should be of concrete.

Concrete. The concrete floor, when properly constructed, meets all the requirements of an ideal floor. It is preferred for the first floor and is being used for upper stories where construction, framing, and reinforcement are ample.

16. Front

The front of the house may be open, or partly enclosed by glass, a good glass substitute, cloth curtains, or a combination of these.

Glass front. Glass helps to light the floor on dark days and offers protection from storm. Through glass the interior of the house warms quickly during the day and cools readily at night. Windows should be arranged to lower and raise if the front is all glass, to avoid too great extremes of temperature in 24 hours in a

house with unisolated walls. Glass is somewhat more expensive than other materials used as substitutes, but unless it is broken it never requires replacing. It should be kept clean, as dust shuts out the light and sunshine.

A disadvantage of ordinary window glass is that it prevents the passage of the ultraviolet rays in the sunshine.

Some glass usually is provided. A good proportion for curtain-front houses seems to be 1 square foot of glass to each 16 or 20 square feet of floor space for conditions in the northern part of the United States. For insulated-wall houses with no open space or cloth, 1 square foot of glass to each 11 to 15 square feet of floor space may be used.

Open front. This type of front admits a maximum of air and sunlight, but allows storms to blow in. For this reason many poultrymen use sliding cloth curtains.

Cloth curtain frames. Where correctly used, curtains give the advantages of the open front without its disadvantages. In the event of storms or winds from the front, they may be raised to cover the openings, and the birds are protected while the curtains allow air movement through the cloth. About 1 square foot of heavy cheesecloth or light muslin to 13 square feet of floor space suits northern United States conditions. More cloth or more open front may be used, depending on the climate.

Curtain frames may be made of 1 by 2-inch material. The frames may be arranged to slide down on the outside between cleats.

Glass substitutes. Many products of wide difference in durability and efficiency in permitting the passage of light, heat, and ultraviolet rays are for sale. The best of these can be used to advantage in the place of glass or cloth curtains, all or in part. Air does not pass through most glass substitutes. They must be used with caution as part of a ventilation system.

Community Survey

1. Which type of laying or brooder house is most popular in the community, the open- or curtain-front, or a closed type? Narrow, wide, square, round? Portable or permanent?
2. How many houses do you know that are ventilated by the rafter method? Wooden flue? Metal flue? Fan?
3. Sketch the air movement in each method of ventilation.
4. What types of wall construction are used?

5. What percentage of the poultry houses are troubled with dampness?
6. What is the apparent reason for dampness in these buildings? Inadequate ventilation? Water receptacles? Type of house or roof?
7. How would you remodel one or more of these houses to make them better?
8. How much floor space do local poultrymen allow for layers? For breeders? Light breeds? Heavy breeds?
9. What depth of house is most popular, and why?
10. Are partitions used?
11. Is there a long house in the community which does not have partitions?
12. How do the birds act in such a house on a windy day?
13. What type of poultry house roof is most common in your area?
14. What reasons are given for its popularity?
15. Do poultrymen prefer concrete or board floors, and why?
16. What kind of material is used on second, third, fourth, or fifth floors?
17. What concrete mixture is used for the foundation? Floor?

References

Write your own state college of agriculture for bulletins on houses or homes for laying hens.

Warren, D. C., R. Conrad, A. E. Schumacher, and T. B. Avery. "Effects of Fluctuating Environment on Laying Hens," *Tech. Bull.* 68, Kansas State Coll., Manhattan, 1950.

Feeding Laying and Breeding Stock

A high degree of skill is required to secure the best results in feeding the domestic fowl. Feeding poultry differs from feeding other stock in that we must feed to suit the needs of the majority or the average of the flock, not the needs of a particular individual. Hens are like machines. The feeder supplies the raw material, and the hen takes it and manufactures a portion of it into eggs. The hens that receive the best selection of raw materials can manufacture most efficiently and turn out the largest quantity of a high-quality product.

By their actions, their appearance, and the eggs they produce, hens show whether or not the feed is suitable. The successful feeder must study his birds, be quick to note trouble, and cater to their appetites. No set rule can be given as to the exact amount that is best. At all times, one should endeavor to feed all that the birds will eat, since maximum intake of the essential nutrients, properly balanced and supplied, permits the hen to express her inbred efficiency and rate of egg production.

Table 3 indicates the remarkable influence of size of layer on the feed required for maintenance and for producing 100, 200, and 300 eggs per bird per year. Assuming that eggs of comparable size and market value can be produced by layers of these various weights, the advantage of lightweight hens in terms of feed needed can be readily seen.

The large expansion in size of poultry flocks, the necessity of reducing the amount of labor involved in egg production, and advances in knowledge of the nutritive and energy requirements of hens have resulted in easier and more efficient methods of feeding. These methods are becoming more popular because they reduce the hazard of the human factor. They rely more and more upon the hen's instinct for choosing the feeds best suited to her daily needs.

Table 3. Feed Required by Chickens of Different Live Weights for Maintenance and for Production of 0, 100, 200, and 300 Eggs per Year¹

Average Live Weight, lb.	Average Total Feed Required per Bird per Year, lb.			
	0 Eggs	100 Eggs	200 Eggs	300 Eggs
3.0	47	61	75	89
3.5	52	67	81	95
4.0	57	71	85	99
4.5	61	75	89	104
5.0	65	80	94	108
5.5	70	84	98	112
6.0	74	88	102	116
6.5	78	92	106	120
7.0	81	96	110	124

¹ From *Nutrient Requirements for Domestic Animals*, "Nutrient Requirements for Poultry," revised January 1954, a report of the Committee on Animal Nutrition, Agricultural Board, National Academy of Sciences, National Research Council Publ. 301.

The success of modern-day poultry feeding no longer depends on home-mixed rations. Research in poultry nutrition has made and is continuing to make great strides. This information is made available through bulletins, letters, lectures, and special nutrition schools. Commercial feed concerns maintain extensive laboratories where individual feeds are tested for their nutrient content, and because of the volume of their business these firms can afford to be discriminating in their purchases, ensuring the finest ingredients.

The producer can make no better choice of individual feeds nor build better mashes. The customary procedure today is to purchase the various mashes desired from reliable commercial feed concerns. Grain rations may be purchased ready mixed, or the whole or cracked grains may be purchased separately and mixed as they are emptied into the feed bins.

Operations:

1. Essentials in feeding.
2. Methods of feeding.
3. Feeding grain
4. Feeding mash
5. Feeding animal protein, green feed, grit, shell, salt, manganese, and phosphorus
6. Supplying vitamin D.
7. Supplying the water
8. Cooking feed

9. Feeding the different breeds.
10. Feeding breeders.

General information:

1. Grains used for poultry feeding.
2. Mash ingredients used for poultry feeding.
3. Animal protein feeds used for poultry feeding.
4. Green feeds used for poultry.
5. Miscellaneous feeds.

Operations

1. Essentials in feeding

The successful feeder, as a rule, attempts to observe the following essentials in flock feeding: (1) Feed to encourage the birds to eat large quantities of food; (2) provide ample water, grit, and shell; (3) feed grain and mash according to the method selected; (4) send the birds to roost with full crops.

Laying rations may consist of grain and mash fed separately, all mash, or home-grown grains ground and mixed with proper ingredients to make a grain-base mash to be fed with whole or cracked grains. The proportion of grains and mash fed in any case will depend on the make-up of the mash, the individual preference of the birds themselves, or the desires of the feeder.

2. Methods of feeding

The choice of the method of feeding is determined by the experience of the feeder and his ability to observe the needs of the birds as they change from day to day, by the amount of time or help available, by the inherited egg-producing capacity of the birds, by the age of the birds, by the preference and prejudices of the operator, by the relative cost of mash and grains, and sometimes by the breed or variety.

The controlled grain method. *Litter fed.* In this method of feeding laying hens, a standard laying mash (from 18 to 20 per cent protein) is available at all times. Grain is fed sparingly or not at all in the morning, but in the late afternoon the birds are given all the grain they will eat. It is scattered by hand in the litter to induce the birds to scratch for it and to keep the litter loose and dry. The amount of grain is increased or restricted to control mash consumption. The aim usually is to have the layers eat approximately equal amounts of grain and mash. At times this rela-

tionship may change considerably. For example, in cold weather nearly twice as much grain as mash may be eaten, and in warm weather less grain may be consumed than mash. These variations are not of consequence so long as the total daily intake of feed continues high. During cold weather it may be advisable to give a small feeding of grain at noon to keep the birds active. Any of the morning grain left in the litter at noon indicates that too much has been given in the early feeding. A good plan is to give about three-fourths of the grain at night and the rest in the morning and at noon.

The controlled grain method of feeding has been generally followed for many years. It is used at most laying tests, and by a majority of commercial poultrymen. There is some evidence that, with birds of mediocre or inferior inherited laying capacities, better results are obtained by this method of feeding than by the free-choice grain method. However, more skill and experience on the part of the feeder are required.

Trough fed. The trough-fed grain method is a variation of the litter-fed method, but requires somewhat less skill and observation than are needed when the grain is litter fed. Usually the grain troughs are distinct from the mash troughs, but some poultrymen distribute the grain on top of the mash.

Grain fed in troughs should be available early enough in the afternoon for the birds to eat what they want before going to roost. About 4 P.M. is the usual time for opening the grain hoppers, but the time should be adjusted to regulate the proportion of grain to mash. The hoppers may be opened earlier when more grain needs to be eaten.

When all of the grain is fed in troughs, the litter may become packed down and badly soiled. To prevent this and still retain the advantage of trough feeding, some grain may be scattered in the litter in the morning. This applies also to the free-choice grain method. In both methods, however, this increases time and labor.

Trough feeding of grain gives the timid and less active individuals a better chance at the grain.

The free-choice grain feeding method. It should be remembered that, given the opportunity, birds will consume feed to meet the instinctive urge from within, whether they are being raised for eggs or for meat. A standard laying mash is kept before the birds at all times in open feeders. The grain, likewise, is kept constantly before the birds. Usually no effort is made to influence the amount

of grain or mash eaten. If several grains are fed, they may be mixed or each may be fed in separate feeders. A variation of this plan is to feed one grain, such as wheat or oats, by hand in the litter. The birds working in the litter help keep it loose and dry.

The free-choice grain method permits layers to select the amounts of grain and mash, as well as the kind of grains, that satisfy their individual needs. Since laying hens must be fed as a flock, yet have varying individual requirements, the free-choice method may allow them to meet those needs more closely than does any other method.

Most of the minerals and vitamins required by laying hens are included in the mash. If considerably less mash than grain is eaten, as might be the case with free-choice feeding, especially in cold weather, possibly there may not be enough minerals and vitamins in the diet. In actual practice, however, this difficulty is seldom experienced, probably because standard laying mashes usually carry excess amounts of these nutrients. When the grain intake greatly exceeds the mash consumption, it may be well to increase some of the ingredients in the mash or grain to guard against these deficiencies. For example, it is well to mix extra feeding oil with the grain (see page 110) or to otherwise increase the vitamin D in the ration. The same result could be accomplished by restricting the grain feeding temporarily, although this is dangerous and may be followed by loss of weight and molt.

The method is particularly well suited to the inexperienced poultryman and is used to some extent on large commercial egg farms. An advantage to the caretaker is the convenience; no definite time for feeding the grain is required, and more grain can be carried to the birds at one time.

With nearly all birds that have been bred and selected for high egg production, the free-choice method of feeding laying pullets has generally resulted in egg production, egg size, body weight, and viability equal to those obtained by controlled grain feeding.

Until recently the success obtained by free-choice feeding has not been well understood, but liberal use of high- and medium-energy grains provides the answer, since corn, wheat, kaffir, heavy oats, or barley are the basis for high-efficiency rations and feeding programs.

The free-choice grain method with mash concentrate. The mash concentrate method of feeding laying hens is the same as the free-choice grain method except that the mash has a higher protein content. Its aim is to ensure a normal intake of protein, vitamins, and minerals by the laying birds, even though they eat much more

grain than mash. Results of limited experiments by this method of feeding do not indicate that it has any advantage over other methods.

3. Feeding grain

Each method of feeding, except the all-mash method, differs principally in the way scratch grain is fed. Grain is the chief source of energy and heat-producing nutrients. Grains may be fed whole or cracked.

Grains differ in their fiber content and can be fed in several combinations. Corn or wheat, being high in digestibility and energy values, may be $\frac{1}{2}$ to $\frac{3}{4}$ of the grain mixture, with oats, barley, buckwheat, or other grains in smaller amounts. According to *Cornell Feed Service*, November 1951, the following are maximum levels per ton for any one grain:

Grain	Maximum Usage Level per Ton of Scratch Mixture, lb.
Corn (whole or cracked)	1500
Wheat	1500
Oats (heavy)	800
Oats (light)	500
Barley	800
Buckwheat	400

Many flocks of pullets prefer somewhat more wheat than corn, whereas molting hens and older birds often prefer more corn than wheat. They may be fed according to their preference.

In any method of grain feeding that permits individual choice among hens, those eating an excess of corn may lay eggs with deeper colored yolks.

Using home-grown grains. In addition to their ordinary use as scratch grains, high-energy grains may be ground and mixed with properly compounded mixing mashes at the rate of $\frac{3}{5}$ coarse-ground grains to $\frac{2}{5}$ mixing mash to form the mash of a grain and mash ration. Corn or wheat, because of their high energy value, should constitute at least half of the grain used in the 1200 pounds in Table 4. The ingredients in mixing or regular mashes today require commercial machinery for thorough blending.

Table 4 shows various combinations that may be used to make 1200 pounds ($\frac{3}{4}$ of a ton) of a grain mixture, ground and mixed

with 800 pounds ($\frac{2}{3}$ of a ton) of mixing mash. Each vertical column of Table 4 totals 1200 pounds of the grains involved.

Table 4. Grain Mixtures to Make 1200 Pounds¹

Ground Grain	Mixtures, lb. ²					
	800		600	800	800	600
Cornmeal	800		600	800	800	600
Corn and cob meal	..	800	..	..	...	...
Wheat (coarse ground or crushed)	200	400	..	...	..	200
Oats, heavy	200	..	600	..	...	200
Oats, light	...		..	400	..	..
Barley	...	..	..	...	200	...
Buckwheat	..	..	..	...		200
Rye	..	..	...	..	200	...

¹ *Cornell Feed Service*, November 1951.

² Mix with 800 pounds of mixing mash.

For adequate layer and breeder mixing mashes, mix 800 pounds of the mixing mash in Table 5 with 1200 pounds of any combination of ground grains shown in Table 4. When thoroughly blended, the mash may be used in any combination of grain and mash feeding described under "Methods of feeding," page 103.

Table 5. Mixing Mashes for Layer and Breeder Mashes¹

Ingredients	Layers, lb./ton	Breeders, lb./ton
Wheat flour (or standard) middlings	50	20
Soybean meal	1100	800
Fish meal	...	200
Meat scrap	250	200
Corn distillers' dried solubles	...	125
Dried whey	...	125
Alfalfa meal	250	250
Riboflavin supplement to supply (mg. riboflavin)	1000 mg.	3000 mg.
Vitamin B ₁₂ supplement to supply (mg. B ₁₂)	...	7 mg.
D-activated animal sterols (1500 I.C.U./gm.)	5	5
or	or	or
Vitamin feeding oil (300D, 1500A)	25	25
Steamed bone meal	225	150
Limestone	50	75
Salt (iodized)	50	50
Manganese sulfate (65% feeding grade)	1.2	1.2

¹ *Cornell Feed Service*, November 1951.

4. Feeding mash *

In all methods of feeding laying hens, a *dry mash* is always available for it supplies the bulk of the protein, minerals, and vitamins required by the birds. A standard laying mash usually contains from 18 to 20 per cent of protein. To prevent the accumulation of stale mash, the old mash should be brushed to the ends of the feeders before fresh mash is added, or fresh mash should not be added until the feeders are practically empty.

Dry mash may be supplemented with moist mash in all methods of feeding. *Moist mash* is fed when the birds are inactive or otherwise might not eat their normal amount of feed. Moist mash may be fed in either of two ways: (a) by pouring milk or water onto the dry mash in the hoppers at the rate of from 1 quart for 100 birds, or (b) by mixing water or, preferably, milk with dry mash to a crumbly state. It should be fed in the afternoon and before the night feeding of grain. Only as much should be given as will be eaten readily. An objection to the first method of feeding moist mash is that some of the liquid may get beneath the dry mash by running down the sides of the feeder. The mash not eaten may freeze or mold. Care should be taken to pour the liquid only where it will remain on the top of the mash, and to limit the amount to what will be eaten in a half hour. Mash in the form of *pellets* may be fed as a supplement in place of the moist mash.

The all-mash method of feeding uses no whole or cracked grains. The mash has a protein content of from 15 to 16 per cent. Mash is kept before the birds in open feeders at all times. Moist mash is fed when it seems advisable to ensure adequate feed intake. All-mash rations must be coarsely ground.

Automatic feeders have focused attention on the need for all-mash laying rations.

This method has all the time-saving advantages of the free-choice method (page 104) and also gives a more constant intake of protein and vitamins. Until recently, it has not found favor with many poultrymen, chiefly because of the difficulty of getting the laying birds to eat enough mash to sustain maximum production and to maintain body weight. In general, experimental results favored grain and mash feeding.

Since the importance of and proper attention to high-energy feeds have been recognized, and high-energy feeds have been incorporated in all-mash rations, better results are being obtained. Properly formulated all-mash rations are giving satisfactory results in egg production. However, the cost of grinding and mixing them may

* H. E. Botsford, G. F. Heuser, and L. E. Weaver, "Methods of Feeding Laying Hens," *Cornell Ext. Bull.* 338, Cornell Univ., Ithaca, N. Y., 1913.

give higher costs per dozen eggs than the usual grain and mash rations.

5. Feeding animal protein, green feed, grit, shell, salt, manganese, and phosphorus

Meat scrap, fish meal, milk, or some other form of *animal protein* is a desirable part of the ration and supplies minerals, vitamin B₁₂, unidentified nutrients, and protein. The hen is naturally a meat eater.

A minimum of 3 to 4 per cent of the total ration should be animal-protein feed. It is usually fed as part of the mash mixture. The balance of the required protein may be of vegetable origin. (See soybean oil meal, page 113.)

Feeding green feed is a practice that has decreased over the years. Green feed is, however, rich in vitamins and, when fed, will increase the vitamin content of the total ration. In this sense it is a protective feed. Modern dependable commercial mashes are provided with the necessary factors which green feeds supply. Therefore, green feeds are best used when there is doubt concerning the mash in use. Too much succulent feed may decrease grain and mash consumption. Five per cent of alfalfa leaf meal in the mash, or 5 pounds of cabbage or other green feed to 100 hens, may be given each day at noon or in the late afternoon. See page 134 for feeds containing carotene and xanthophyll.

Grit and shell should always be before the birds, in hoppers or boxes. Grit should be hard. It is used to crush feed in the gizzard and is not itself a feed. Grit does for the hen what teeth do for other animals. Nothing passes through the bird's body that is not thoroughly ground and pulverized by the gizzard.

In Cornell tests it was found that granite grit with oyster shells is preferred; the second choice is calcite grit, which serves as both grit and a calcium source.* Compared with shells alone, 0.7 pound per hen of granite grit in addition to shells increased the average production per bird in 42 weeks of the test by 15 eggs and reduced the amount of feed per dozen eggs by 8 per cent.

Oyster shell contains calcium carbonate, thus supplying calcium, which is an egg-shell and bone-making material and a very important mineral in poultry feeding. Without a source of calcium,

*G. F. Heuser and L. C. Norris, "Oyster Shells, Calcite Grit, Ground Limestone, and Granite Grit in Rations for Hens," *Poultry Sci.*, March 1946, p. 173.

soft-shelled eggs are likely to result, together with the habit of egg eating.

Crushed oyster shells gave stronger egg shells and maintained body weight better than other calcium sources used in the Cornell test.

Salt aids digestion by rendering the feed more palatable. It supplies sodium and chlorine, two essential minerals present in insufficient amounts in common feedstuffs. The exact amount needed has not been determined. As with other animals, large amounts of salt will injure the birds if they are forced to eat it. It is customary, therefore, to add salt to the mash in amounts of 10 pounds per ton, or 5 to 10 ounces per 100 pounds. A wall hopper of salt in the pen permits the birds to supplement their needs and is being used with no harmful effects.

Manganese deficiency results in low egg production, slightly decreased fertility, and low hatchability. The addition of $\frac{1}{4}$ pound of anhydrous manganese sulfate or manganese carbonate, thoroughly mixed in each ton of mash for layers or breeders, usually corrects a deficiency of this mineral. It also checks perosis in chicks.

Phosphorus is needed in small amounts to balance the calcium-phosphorus ratio in the blood and bones. This ratio is roughly 2 to 1. Part must be in the inorganic form since organic forms, being locked up in the form of *phytin phosphorus*, are not utilized well by poultry. The phosphorus value of a mash is best indicated as available phosphorus in steamed bone meal, dicalcium phosphate, and defluorinated rock phosphate, plus 30 per cent of the organic phosphorus in the mash. Rock phosphate containing 0.3 per cent fluorine has had no harmful effects on poultry.

Large amounts of minerals, when birds are forced to eat them, are harmful. Judgment and precaution are as essential in the use of minerals as in determining the other ration ingredients.

6. Supplying vitamin D

Feeding oils are one of the sources of supply of vitamin D for poultry feeding (see page 135). The number of units of vitamin D contained is listed, with the material available. Whereas formerly units of vitamin D were given in A.O.A.C. units, they are now given in I.C.U. (International Chick Units).

Feeding oil is usually mixed in the mash as it comes from the dealer. Should additional vitamin D be needed for any reason, it may be mixed in the mash at the mill or fed in the grain by the

poultryman. The grain should always be trough- or hopper-fed when mixed with the oil, since it will collect dirt if scattered in litter and some of the oil may be rubbed off on the litter and lost. The mash, of course, will be fed in hoppers.

How to mix. Spread over the grain as it is being emptied into the storage bin, or spread over the entire pile and mix. Do not mix more than a two weeks' supply at any one time, as the vitamins of feeding oil are subject to oxidation in the presence of air.

Sterols. In recent years, D-activated animal sterols have been used to fortify and standardize the feeding oils in vitamin D potency. Sterols supply vitamin D only, whereas feeding oils contain both A and D. Sterols are a product of brains and spinal cords from beef animals or similar materials from marine animals, subjected to irradiation to synthesize and manufacture the D vitamin.

7. Supplying the water

The birds must have access to water during the entire day. Water softens the food in the crop and in other parts of the digestive tract, thereby making it ready for grinding and digesting. It serves as a carrier for transporting nutrients in the body, as blood. The hen's body is 55 per cent and eggs are 65 per cent water. A constant supply of water must be available, therefore, to keep up the composition in the body and to help make eggs. Water, coupled with rapid breathing, keeps the inside of the hen's body cool in summer and is the only means of cooling from the inside. As a result, birds use much more water on warm days and during heavy laying periods.

Water is as important as feed and must be supplied regularly and in sufficient quantities.

8. Cooking feed

It is not considered profitable commercially to cook feed. Cooking or exposing to high temperatures reduces the protein value of some feeds. However, the protein of ground soybeans is made more efficient by heating the beans. When field beans or potatoes are fed, cooking renders the starch more digestible.

9. Feeding the different breeds

When one is feeding for egg production, the practices outlined in this chapter may be applied to any breed. The heavier varieties

may require somewhat more care on the attendant's part and probably more restricted grain feeding to keep them active. They have more tendency to become fat than do Leghorns.

10. Feeding breeders

Breeders are fed the same as layers. More animal-protein feeds, riboflavin and vitamin B₁₂ are required for high hatchability. Properly prepared commercial mashers meet this situation.

General Information

Composition of ingredients commonly used for poultry will be found on pages 128-129.

1. Grains used for poultry feeding

Yellow corn, a desirable poultry feed and one of which fowl are fond, is best when fed with other grains. It is a high-energy feed, containing a large amount of digestible nutrients and supplying vitamin A, and fits well in a ration. Yellow corn is usually cheap and can be easily raised, transported, and stored. As a part of the grain mixture, it is generally fed cracked, but it may be fed whole with equally good results after the birds are 10 or 12 weeks old. It is a xanthophyll-bearing feed and imparts yellow color to the yolk and yellow pigment to the skin.

Wheat is a high-energy feed and very palatable, especially throughout the first laying year. It is adaptable to feeding fowl because of its size, color, and the large amount of nutrients which it contains. It should be fed with other grains. Soft or hard wheats and shrunk wheat which is wholesome are desirable for poultry feeding.

Barley is not so palatable as wheat but makes a fairly desirable ingredient for poultry rations. Barley and heavy oats are medium-energy feeds.

Oats are a valuable poultry feed. The hull may possess a factor which lessens the cannibalistic desire of poultry. Five to 20 per cent or whatever the birds will eat may be included in the grain ration. Some poultrymen provide free-choice hoppers of oats in the laying pens. They should not be fed as the only cereal.

Kafir corn has a composition much like wheat. The kernel is small and quite palatable. It is not quite equal to yellow corn in

feeding value but may replace it in part. It is a high-energy grain.

Buckwheat is a low-energy feed. It has a heavy shuck and should be fed in small amounts. It produces a light-colored egg yolk.

Rye is unpalatable to poultry. It may be fed in small quantities with other grains.

2. Mash ingredients used for poultry feeding

Cornmeal is the clean, ground product of the entire corn kernel. It is an efficient and palatable feed. Generally it should form a part of the mash mixture. Yellow cornmeal is more valuable than white owing to its vitamin A potency, a factor white corn does not possess.

Red dog flour is a low-grade flour but a high-energy poultry feed, and is valuable especially in fattening rations.

Ground heavy oats are a highly desirable constituent of the mash. They are rather bulky. They may comprise as much as 25 per cent of the mash mixture, but ordinarily, because of the high fiber content, smaller amounts are used.

Soybean oil meal, a valuable source of vegetable protein, is a by-product from the manufacture of soybean oil. It can be used in the mash to replace three-fourths of the meat scrap or fish meal, substituting 6 pounds for each 5 pounds of animal-protein feed removed. Raw soybean meal is inadequate. The protein is not available to poultry until heated. Although its composition shows ample phosphorus, much of it is organic and not usable by poultry, and forms of inorganic phosphorus must be included in the ration (page 110).

Linseed oil meal is rather laxative in its effect. It is a high-protein feed, but is not palatable to poultry, probably because it is sticky. It should not be fed in amounts exceeding 5 per cent of the mash. Some authorities say it cannot be recommended for use in any poultry ration.

Hominy feed may be used in the same way as cornmeal, the yellow variety being preferable to the white. It is not quite equal to yellow corn in feeding value.

Corn gluten meal is high in protein and vitamin A. It may replace one-half of the meat scrap in a laying ration.

Wheat bran is bulky, low in nutriment, slightly laxative, and a low-energy feed.

Wheat standard middlings are very similar to wheat bran but are ground more finely, and are less bulky and slightly more nutritious.

Wheat flour middlings are higher in energy and somewhat more nutritious than the standard middlings. Although a more sticky feed, this stickiness is not a handicap in the usual mash mixture. It is valuable as a mash constituent.

Wheat mixed feed is a mixture of wheat bran and middlings, more or less variable in the proportion of these ingredients. Its composition is between the two, and it may be used in place of them.

Cottonseed meal, though high in protein, is used sparingly in poultry feeds. When decorticated, i.e., when the toxic substance gossypol contained in the central portion of the seed is removed, the meal may be used to comprise 20 to 30 per cent of the mash in starter and grower mashes in areas of great production and where other vegetable proteins are scarce. In laying rations, the olive coloring cottonseed meal gives to the yolks is reduced considerably by decortication. The fiber content is too high, however, making cottonseed meal less efficient than soybean meal in any ration.

3. Animal protein feeds used for poultry feeding

Protein from animal feeds supplements proteins of vegetable origin and provides a more complete assortment of the essential amino acids. (See page 120.)

Meat scrap is one of the most desirable animal feeds. It is the most convenient form of meat but may vary widely in feeding value, depending on the amount of by-product material included.

Fish meals. The protein content in fish meal is usually higher and of better quality than that in meat scrap. When properly prepared, fish meal is believed to be richer in vitamins and manganese than most meat products fed to poultry.

Tankage is less suitable for poultry than is meat scrap. The birds do not like it so well as some other animal feeds. It is less uniform in quality and does not produce as good results as does meat scrap.

Blood meal is less suitable for poultry feeding than meat scrap or fish meal. It is high in protein, but is unpalatable.

Liquid or dried skim milk, buttermilk or whey, and the condensed milk products are valuable sources of riboflavin and animal protein. They are easily digested, palatable, and increase the digestibility

of the entire ration. Experience also indicates that if liquid skim-milk or buttermilk is constantly available, the birds will receive sufficient riboflavin.

Distillers' solubles are high in riboflavin and may replace milk products for that nutrient.

4. Green feeds used for poultry

Alfalfa meal is a valuable feed. Like clovers and some pasture grasses, it is a good source of vitamins. (See table, page 128.) For this reason and because of its availability, it is well adapted as a mash ingredient. Three to 5 per cent of alfalfa meal in the mash supplies the necessary green food without excessive yolk coloring. It is not a succulent feed. Sun-cured alfalfa is much less valuable as a source of vitamin A than is dehydrated alfalfa meal. There is a slight loss in the latter by oxidation during dehydration and in outdoor wilting. Dehydrated alfalfa meal and sun-cured alfalfa meal are about three-fourths and one-half as rich, respectively, in riboflavin as is dried *skim milk*.

Green pasture provides green food in the most natural form. Its use on range for breeding birds and for rearing is desirable because of its palatability, succulence, high digestible protein, mineral, and vitamin content. It is high in xanthophyll. A proper green range may slightly reduce the food cost for rearing.

Results at Cornell * showed only moderate savings in feed cost. Good pasture, compared to ordinary pasture, permitted slightly restricted feeding and a feed saving of 3 to 8 per cent with no unfavorable influence on weight, sexual maturity, or mortality. The best use of pasture came from a modified ration saving the cost of protein and vitamins, consisting of whole wheat for the grain and ground wheat for the mash.

Add to 100 pounds of ground wheat:

4 pounds dicalcium phosphate

1 pound calcium carbonate (ground limestone)

1 pound iodized salt

Wheat contains sufficient manganese.

In other sections corn has been used for the grain.

Investigations indicate that Ladino clover and Kentucky bluegrass are of special value in poultry pasture mixtures for the North-

* G. F. Heuser, L. C. Norris, and J. H. Bruckner, "Pasture Experiments with Growing Pullets," *Cornell Bull.* 823, Cornell Univ., Ithaca, N. Y., 1915.

east. Best feeding value is obtained when the pasture is closely grazed or kept mowed to a height of 3 to 4 inches.

A poultry pasture mixture suggested by Cornell:

Ladino clover	2 pounds per acre
Kentucky bluegrass	12 pounds per acre

Ladino clover seed may be sown on carefully prepared land to which has been added 400 to 600 pounds of superphosphate and 100 to 200 pounds of muriate of potash per acre, and lime if needed. Excellent results have been secured when Ladino clover seed is broadcast on sod land which is sweet and well fertilized, as a used poultry range may be. Pasture seeded in early spring is ready for use the following season, or it may be used the same midseason if necessary and if it is not overstocked.

The *North Central States* find Sudan grass, the vetches, alfalfa, clovers, and the green growth from planting small grains adapted to their conditions.

Corn silage may be used in small amounts.

5. Miscellaneous feeds

Roots and tubers are low in vitamins; hence, they are used very little for poultry feeding.

Molasses may be used to replace some corn. Five per cent is satisfactory, but 10 per cent may cause a temporary diarrhea. Molasses contains the antidermatosis vitamin but is too variable to be a dependable source. It has only slight growth properties and contains little or no riboflavin. Because it contains potassium, it is used in control of blue comb (see page 266).

Community Survey

1. Ask several local poultrymen what rations they are feeding laying hens.
2. What method of feeding grain and mash is followed?
3. What proportion of grain and mash are they feeding?
4. How many trips are made to the laying flock each day in winter?
5. What work is done on each trip?
6. Do they feed the grain by pounds or quarts? Varying with the appetites?
7. How much is given per 100 hens?
8. What determines the amount of grain fed? The amount of mash fed? The form of animal protein fed?
9. Is green feed given to layers, breeders, growing birds?

10. What kind is fed to each?
11. How much is fed? What determines the kind and amount given?
12. How many hoppers for grit and shell are in each pen?
13. Is the water supply sufficient and clean?
14. How is the water kept from freezing?
15. Is home-grown feed used? If so, how?
16. Describe the litter. Condition? Depth? Age? Kind? How often changed for chicks? For adults?

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CHAPTER

7

Principles of Feeding and Formulating Rations

The laying flock uses feed for three purposes: first, for body maintenance; second, for increasing body weight; and third, for increasing and maintaining egg production.

Maintenance of the body is the first consideration in good feeding. Under normal conditions, production follows after the body needs are supplied. Considerable feed is required to build and maintain the body to the point of production. Actual production of eggs requires but a comparatively small amount of food in addition. No profit is derived from merely maintaining the body. Profit comes from growth or production of meat or eggs.

About three-fourths of the total feed consumed is used for maintenance when the fowl is in laying condition. One hundred birds averaging 4.5 pounds will consume about 17 to 18 pounds of feed daily when not laying, and 23½ to 25 pounds when producing 50 to 60 per cent. "Heavies will consume more

Growth. Pullets continue to grow for several months after production starts, and are under a triple demand for food at that time. When not given sufficient food, birds having a high inherited tendency to lay are very likely to continue laying at the expense of maintaining their bodies. They become thin, molt follows, and much production is lost.

Production. Referring to the following table, assume a flock of well-bred light-breed pullets in the flush of early production, laying 60 per cent. The flock is receiving 22 pounds of feed daily per 100 hens. Obviously this production cannot continue long with that amount of feed. The birds cannot maintain the necessary growth and will become thinner, until finally production must drop to a lower point or cease. Self-preservation is the first law of nature,

and too little food inflicts a terrific strain. Full feeding of a proper ration is the answer. Free-choice feeding of grain and mash, or a high-energy all-mash ration constantly before the birds, may often prove more effective than restricted grain feeding.

Table 6. The Relation of Egg Production Rate to Feed Requirement and Efficiency of Production ¹

Rate of Egg Production, per cent	Daily Feed Requirement per 100 Hens, lb.	
	Light Breeds (4.5 lb. av. wt.)	Heavy Breeds (6.5 lb. av. wt.)
0	17	21
20	20	24
40	22	27
60	25	30
80	28	33

¹ *Cornell Feed Service*, November 1953.

General information:

1. Definition of terms.
2. The energy value of poultry feeds.
3. Nutrient requirements for chickens.
4. Suggested levels of nutrient allowances for chickens.
5. Recommended formula patterns for poultry mashes.
6. Feeding recommendations.
7. How to calculate the composition of feed ingredients.
8. Further feed factors.
9. The importance of vitamins and antibiotics in feeding poultry.

1. Definition of terms

There are a number of terms which should be defined before the principles of feeding are discussed further.

A *nutrient* is any constituent of a feed that goes to produce heat and energy and to control vital body processes. These consist of protein, carbohydrates, fat, minerals, vitamins, and water.

A *ration* consists of all of the required nutrients in adequate amounts for the purposes intended.

Feeds are composed of water and dry matter. The amount of water in feeds varies greatly, but is not sufficient to supply the bird's needs; therefore, water must be furnished.

Dry matter is made up of inorganic and organic substances. The inorganic matter is composed of minerals or ash. The organic sub-

stances consist of combustible material, such as sugar, starch, fat, protein, and fiber.

Ash, an inorganic constituent, is present in small quantities in all feeds and in all parts of the body, and is a noncombustible material. It is used in the building of bone and in making egg shells. It is of more importance in the feeding of young stock than of mature stock, since large amounts are needed for building the framework of the growing body. Ash is usually present in feeds in sufficient quantity to supply the adult fowl's needs, with the exception of calcium for making egg shells, which should be supplied in the form of oyster shell or limestone.

Protein is used principally to form the muscle tissue, hair, nerves, and feathers in the fowl and the albumen or white of the egg. It is essential in the building of tissue and in egg production. Consisting of compounds which contain nitrogen, it is an indispensable and generally the most expensive part of a ration. No nutrient will take the place of protein, but a part of the protein is sometimes used as fat-forming material or energy. Because of its cost, any excess of protein in the ration should be replaced by carbohydrates or fats.

There is no specific disease due to a shortage in protein, although poor growth or reduced production will result. An excess of protein may be used as energy. A larger amount may be thrown off by the birds through an extra strain on the kidneys, and in time a whitish discharge will gather about the vent in high-producing birds.

Protein comes from both vegetable and animal sources. Both are necessary in the poultry ration.

Amino acids are smaller units of protein. Proteins are fed because of the amino acids they contain. All proteins do not contain the same amino acids, nor are the amounts of similar amino acids the same in different feeds.

There are twenty-three known amino acids involved in nutrition. Eleven of these are essential for chickens. Others are classed as unessential, since the body can manufacture them. It is not yet known which amino acids are essential for the various life functions, such as best egg production. Neither is there complete data concerning the amount and kind of amino acids in various proteins.

Since individual feeds may contain more than one protein, the problem is even more complicated. Many different proteins of varying amino-acid relations make up the body. To balance a

ration from the protein and amino-acid standpoints, we should know the amount and kind of amino acids needed by the bird and their content in various proteins in the different feeds. This information is still incomplete. A poultry ration should consist of proteins from a variety of sources, in the hope that the birds may get the amino acids they require.

It is known that animal proteins contain more of the essential amino acids. Hence, their very great importance in the ration.

Carbohydrates include two classes of substances, fiber and nitrogen-free extract.

Fiber is the woody portion or cellulose tissue of plants. In the fowl, the fiber is digested only in a slight degree and apparently in the caeca, probably the result of bacterial action. By distending the intestines, it allows the digestive juices to act more readily. From 3.5 to 5 per cent of the entire ration is ample.

Nitrogen-free extract is used by the body for fuel, which furnishes energy and heat. Any excess is stored as fat. Nitrogen-free extract is made up mostly of starches and sugars.

Fat has the same function as the nitrogen-free extract, in that it furnishes energy and heat, and in that, if more is supplied than is needed for this purpose, the excess is deposited as fatty tissue. Fats, however, are more effective than starches or sugars, and give $2\frac{1}{4}$ times as much energy for each unit of weight.

Protein-energy ratio. This term means the amount of protein in the feed or group of feeds as compared with the combined carbohydrates and fat. When we say a ration has a protein-energy ratio of 1 to 5, we mean that it contains one part of protein to every five parts of carbohydrates and fat. For egg production a protein-energy ratio of 1 to 4.5 or 1 to 5.5 is desirable.

2. The energy value of poultry feeds

The energy value of poultry feeds is a relatively new factor in forming rations. Energy is the fuel value of feed. The need for energy is the largest nutritional need of chickens (indeed, of all animals) and is provided for mainly by the grains and grain products which make up 60 to 80 per cent of the poultry ration.

Many of the cereal grains and their by-products are high in energy (see Table 7). Certain feeds formerly used extensively, such as standard wheat middlings and wheat bran, are low in energy. A high-energy ration requires somewhat less feed to satisfy the

birds and accomplish its purpose. Full feeding is necessary, however, and any attempt to limit the food available may be disastrous. In formulating a ration for the purpose intended, careful attention to its maximum energy values and to the recommended nutrient allowances should prove profitable.

Table 7. Productive Energy Values of Poultry Feedstuffs¹

Grain Products	Calories per Lb.	Protein Feedstuffs	Calories per Lb.
Corn	1145	Soybean meal, 41%	649
Milo	1144	Soybean meal, 41%	565
Kafir grain	1078	Fish meal	898
Wheat	1024	Meat scraps	724
Wheat red dog flour	1020	Corn gluten meal	839
Wheat flour middlings	720	Peanut meal	731
Wheat standard middlings	581	Cottonseed meal	694
Wheat bran	478		
Oatmeal, feeding	1155	Other Feedstuffs	
Heavy oats	817	Alfalfa leaf meal	314
Oats, average	760	Alfalfa meal	261
Light oats	642	Corn distillers' dried solubles	853
Barley	811	Hominy feed	866
Rye	817	Dried skimmilk	525
		Molasses	714
		Oil, corn	2100
		Dried whey	490
		Dried yeast	476

¹ From Extension Stencil No. 226, Cornell University.

3. Nutrient requirements for chickens

Knowledge of vitamins and minerals has progressed until definite requirements for many of these essential ingredients are known, listed, and used in formulating complete rations.

The requirements established by the National Research Council have become the standard upon which many rations are formulated. Table 8 shows the Council's recommendations (1954).

4. Suggested levels of nutrient allowances for chickens

Table 9 is a guide to the amount of the nutrients needed in the mash in order that when both grain and mash are consumed the requirements will have been met, with extra margins of safety.

Table 8. Nutrient Requirements for Chickens¹

(in percentage or amount per pound of feed)

Requirement	Starting Chickens, 0-8 Weeks	Growing Chickens, 8-18 Weeks	Laying Hens	Breeding Hens
Total protein, per cent	20	16	15	15
Vitamins				
Vitamin A activity (U.S.P. units) ²	1200	1200	2000	2000
Vitamin D (I.C.U.)	90	90	225	225
Thiamin, mg.	0.8	?	?	?
Riboflavin, mg.	1.3	0.8	1.0	1.7
Pantothenic acid, mg.	4.2	4.2	2.1	4.2
Niacin, mg.	12	?	?	?
Pyridoxine, mg.	1.3	?	1.3	1.3
Biotin, mg.	0.04	?	?	?
Choline, mg.	600	?	?	?
Folacin, mg.	0.25	?	0.11	0.16
Minerals				
Calcium, per cent	1.0	1.0	2.25 ³	2.25 ³
Phosphorus, per cent ⁴	0.6	0.6	0.6	0.6
Salt, per cent ⁵	0.5	0.5	0.5	0.5
Potassium, per cent	0.2	0.16	?	?
Manganese, mg.	25	?	?	?
Iodine, mg.	0.5	0.2	?	15
Magnesium, mg. ⁶	220	?	0.2	0.5
			?	?

¹ These figures are estimates of requirements and include no margins of safety.² May be vitamin A or pro-vitamin A.³ This amount of calcium need not be incorporated in the mixed feed, inasmuch as calcium supplements fed free choice are considered as part of the ration.⁴ At least 0.45% of the total feed of starting chickens should be inorganic phosphorus. All of the phosphorus of non-plant feed ingredients is considered to be inorganic. Approximately 30% of the phosphorus of plant products is non-phytin phosphorus and may be considered as part of the inorganic phosphorus required. A portion of the phosphorus requirement of growing chickens and laying and breeding hens must also be supplied in organic form. For birds in these categories the requirement for inorganic phosphorus is lower and not as well defined as for starting chickens.⁵ This figure represents salt or sodium chloride added as such or in marine or fermentation products of high sodium chloride content.⁶ Mg. is milligrams.

Table 9. Summary of National Research Council Nutrient Requirements and Suggested Practical Nutrient Levels for Chickens¹

Nutrient	Baster		Cresset		Layor		Foster	
	NRC	Practical	NRC	Practical	NRC ²	Practical	NRC ²	Practical
Protein, per cent	20	20-21	16	16-17	15	15-16	15	15-16
Calcium, per cent	1	1-1.3	1	1-1.3	1.5-2.0	1.5-2.0	1.5-2.0	1.5-2.0
Phosphorus, total, per cent	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7
Phosphorus, available, per cent	0.45	0.45	?	0.6	0.6	0.6	0.6	0.6
Manganese, mg/lb	25	25	15	15	15	15	15	15
Vitamin A, U.S.P./lb	1200	2000	1000	1000	2000	2000	2000	2000
Vitamin D, I.U./lb	50	135	50	135	50	50	50	50
Biotin, mg/lb	1.5	1.6	0.6	1.0	1.0	1.0	1.0	1.0
Vitamin B ₁₂ , mcg/lb	4	4	?	7	?	?	?	?
Niacin, mg/lb	17	14	?	14	?	?	?	?
Pantoic acid, mg/lb	4.7	5	6.2	5	6.2	6.2	6.2	6.2
Choline, mg/lb	600	600	?	?	?	?	?	?

¹ W. Hill, M. L. Scott, L. C. Norris, and G. F. Hewner, "Nutritional Requirements of Poultry," *Commercial Poultry Nutrition* (1974).² Oyster shell or other calcium supplement should be fed with these rations. These are indicated values based on a diet containing 16% protein and 1% fat. Nutritional values are based on a diet containing 16% protein and 1% fat.

Table 10. Recommended Formula Patterns for Poultry Mash¹

(in pounds per ton)

Ingredients	Starter (All Mash)	Grower (with Grain)		Layer (with Grain)	Breeder (with Grain)
		Confinement	Pasture		
High-energy grain products (corn, wheat, wheat red dog flour, milo, oat meal)	903+	700+	500+	500+	500+
Medium- and low-energy grain products (oats, barley, wheat flour middlings, standard middlings, bran)	0-400	0-600	0-800	0-800	0-800
Vegetable proteins (soybean meal, corn gluten meal, peanut meal)	300-400	350-450	400-500	400-500	300-400
Animal proteins, minimum levels (fish meal, fish solubles, meat scraps)	50-100	50-100	...	...	100-150
Other B-vitamin carriers (dried milk products, dried yeast, dried distillers' solubles, fermentation solubles)	100	100	..	.	150
Dehydrated alfalfa meal	50-100	100	..	100-150	100-150
Additional riboflavin (if needed) ²	+	+	...	+	+
Additional vitamin B ₁₂ (if needed) ²	+	+	...	..	+
Additional vitamin A (if needed) ²	+	+	...	+	+
Vitamin D ₃ (feeding oils or D-activated animal sterols)	+	+	...	+	+
Calcium and phosphorus supplements (steamed bone meal, dicalcium phosphate, defluorinated phosphate, limestone)	30-50	60-80	80-100	100	100
Salt	5	10	20	20	20
Manganese sulfate (65% feeding grade)	0.4	0.5	0.5	0.5	0.5

¹ Cornell Feed Service, February 1933.² Refers to the use of riboflavin supplements, vitamin B₁₂ supplements, and vitamin A sources of guaranteed vitamin content, or other vitamin-rich feedstuffs when the formula is otherwise deficient in any of these nutrients.

5. Recommended formula patterns for poultry mash^{es}

Table 10 gives choices and a range in each of the several necessary groups. Desirable are two or more grains, coarsely ground, and soybean meal alone or in combination with corn gluten meal or peanut meal (the last two meals should be limited to one-fourth of the total in this group).

The table shows the minimum level of fish products when used alone. The higher figure indicates the approximate level of meat scrap when used alone. (Note there is no minimum level for animal protein in mash^{es} for pasture grower or layer with grain.) The vitamin A requirement is adequate when yellow corn, feeding oil, and alfalfa are used. (D-activated animal sterols are without vitamin A; when they are used instead of feeding oil, extra vitamin A must be supplied.) Usually the vegetable proteins are sufficient in these rations. When formulating rations, consider cost, availability, and the levels of nutritive allowances shown in Table 9.

The small amounts of several ingredients in Table 10 require

special equipment for mixing. They are given here for purposes of study.

6. Feeding recommendations

See Tables 8, 9, and 10.

Starter. To be fed as an all-mash ration to chicks until 6 weeks of age. Limited amounts of grain, not to exceed 20 per cent of daily feed intake, may be fed with it during the following two weeks. Manganese sulfate necessary to prevent perosis.

Confinement grower. To be fed to growing chicks from 8 weeks to maturity in confinement or on poor pasture. Designed for feeding free choice with grain. Manganese sulfate necessary to prevent perosis.

Posture grower. To be used with free-choice grain feeding only on good posture supplying abundant succulent forage.

Loyer. To be fed with approximately equal grain intake, according to any good mash-and-grain feeding program.

Breeder. To be fed with approximately equal grain intake, according to any good mash-and grain feeding program. Breeder ration should be fed for at least 4 weeks before eggs are saved for hatching.

When developing complete rations, refer to Table 7 for grain suggestions and to the department of poultry husbandry in your state for available feeds that will supplement those in the table.

7. How to calculate the composition of feed ingredients

Developing a layer ration, mash with grain. Suppose you are to develop a laying ration fed $\frac{1}{2}$ mash and $\frac{1}{2}$ grain. (Reference to section 8, page 132, and the discussion of feeds, pages 112 to 116, may be helpful in making a choice of feeds.)

(1) From Table 10 and the column "Layer (with Grain)," select feeds from each group in an amount *not exceeding* the pounds given for each group. The total should equal about 1000 pounds.

(2) Next, select 2 or 3 grains (Table 7) with energy values which appear desirable. The total should equal 1000 pounds.

(3) Work the proposed ration on Table 11. This is the work table. In the column marked "No. of 100 Lb. per Ton," list the amount, in hundreds of pounds or decimal parts thereof, of each ingredient in a ton. Multiply the amount of each ingredient by its average composition, and enter the result in the appropriate columns. The total for each column is the amount of that nutrient contained in a ton of feed.

EXAMPLE

Assume 150 pounds of alfalfa meal and 900 pounds of corn in the ration. List in the first column alfalfa meal 1.5 ($1\frac{1}{2}$ hundreds in a ton), and corn 9 (9 hundreds in a ton). Multiply by 20.9 and 8.9 respectively, and enter 31.3 and 80.1 in the "Lb. in a Ton" column.

Continue with each ingredient, carrying across the page until protein, calcium, and phosphorus have been found for each. Total the columns to determine total pounds per ton, and divide by 2000 to get the amount of each per pound of feed.

Riboflavin, manganese, pantothenic acid, and niacin are given in milligrams (mg.) per pound. Multiplying the figures in these columns by the total pounds of each ingredient in the mixture and adding the columns gives the total milligrams of each in a ton of feed. Divide by 2000 to get total milligrams per pound.

Carotene is used in determining vitamin A contained in the mixture, and the amount of feeding oil that is needed to meet the requirements and the practical level (see Table 11 and page 130).

When the levels of vitamin B₁₂ in fish products and meat scraps are not known, the approximate total amount may be roughly reached by using values of 40 micrograms (μ g.) of B₁₂ per pound of fish meal, 70 per pound of fish solubles, and 15 per pound of meat scrap.

(4) Check results with Table 9.

(5) Revise the ration if necessary.

Supplemental information. For the following example of an all-mash layer ration,* calculate the composition, using Table 11.

In computing vitamin content, particularly U.S.P. units of vitamin A, the conversion factors given here will be useful.

CONVERSION FACTORS FOR CALCULATING FEED FORMULAS †

1 pound = 454 grams

1 gram = 1000 milligrams

1 milligram = 1000 micrograms

1 microgram per gram is the same as parts per million.

To convert milligrams per gram to milligrams per pound, multiply by 454.

To convert micrograms per gram or per pound to milligrams per gram or pound, divide by 1000.

To convert milligrams per pound to micrograms per gram or parts per million, divide by 0.454 or multiply by 2.2.

1 International Unit (I.U.), U.S.P., of vitamin A equals the activity of 0.6 microgram of B-carotene.

* Cornell Feed Service, November 1952.

† From National Research Council report, 1954.

Table 11. Composition of Ingredients Commonly Used in Poultry Rations¹
(See page 126 for instructions)

Ingredients	No of 100 Lb per Ton	Protein		Calcium		Phosphorus		Riboflavin		Manganese		Pantothenic Acid		Niacin		Carotene	
		Lb in 100 Lb.	Lb. in a Ton	Lb in 100 Lb	Lb. in a Ton	Lb in 100 Lb.	Lb. in a Ton	Mg per Lb.	Mg. in a Ton	Mg. per Lb.	Mg. in a Ton	Mg. per Lb.	Mg. in a Ton	Mg per Lb.	Mg in a Ton	Mg. per Lb.	Mg. in a Ton
Alfalfa meal, dehydrated 20%	20 92			1.7		0.3		7.4		29.8		13.5		17.3		60.03	
Alfalfa meal, dehydrated 17%	17 8 12.7			1.7 0.00		0.2 8.5		7.3 0.8		13.0 8.3		12.3 3.7		8.7 24.1		36.03	
Barley																	
Bone meal, steamed, special	13 4			29.3		15.1		0.4		5.1		0.8		2.0			
Brewers' yeast, dried	46 8			0.1		1.5		14.0		2.4		42.1		213.8			
Buckwheat	10			0.1		0.3		1		36		8		8			
Buttermilk, dried	32 4			1.4		0.9		15.8		1.5		13.5		2.8			
Corn, dent, yellow	8.0			0.02		0.3		0.5		2.3		2.8		9.8		1.33	
Corn gluten meal, 41% protein	42.9 41.2			0.2 0.2		0.4 1.2		0.7 2.5		4.4 12.9		3.8 4.4		24.8 13.0		10.0	
Cottonseed oil meal, 41%				28.3		12.3				40.9							
Defluorinated phosphate				26.5		20.5											
Dicalcium phosphate																	
Fish meal, menhaden	62.2			5.0		3.4		2.4		10.0				23.9			
Fish meal, sardine	67.2			4.2		2.5		2.5		10.3		1.3		26.0			
Fish robbles	29			0.1		0.8		10				18		160			

	11.1	0.05	0.7	1.0	6.9	3.5	22.5	0.5
Honey feed, yellow	....	39	....	....	....	..	....	....
Limestone	52.9	8.7	4.4	2.4	4.0	2.1	27.1	....
Meal scrap, 50% protein	50.0	9.7	4.2	2.1	5.3	1.5	21.4	....
Meat and bone scrap,	11.3	0.03	0.27	0.4	....	5.0	13	..
50% protein	12.0	0.09	0.5	0.4	19.2	0.8	8.2	....
Milo	....	37.9	....	....	..	..	..	..
Oyster shell, ground	41.1	0.1	0.6	2.4	....	21.1	77.5	....
Peanut oil meal	31.7	1.3	1.1	10.0	1.2	16.0	5.7	..
Sesamilla, dried	46.1	0.3	0.6	1.4	13.8	6.2	17.1	..
Soybean meal, solvent	15.2	0.05	0.4	0.5	18.0	6.3	24.1	..
Wheat, hard	....	....	0.3	0.5	27.7	5.2	26.8	....
Wheat, soft	10.4	0.1	1.3	1.4	56.0	15.0	63.5	..
Wheat bran	18.1	0.07	0.6	0.8	39.0	4.5	44.2	..
Wheat flour middlings	17.0	0.1	0.8	0.8	53.0	9.3	44.3	....
Wheat standard mid-	32.2	0.9	0.8	13.0	1.1	22.4	5.1	....
dings								
Whey, dried								
Total per ton								
Total per pound								

† More complete tables giving the average composition of feeds, vitamin A, and amino acid content of poultry feeds will be found in G. F. Heuser, *Feeding Poultry*, 2nd ed., John Wiley & Sons, New York, 1933.

‡ The data on the average composition of feedstuffs were supplied by the Committee on Feed Composition, National Research Council, 1954. They are a combination of data compiled by the Committee on Feed Composition and by F. B. Morrison (*Feeds and Feeding*, 21st ed.), who is a member of this committee.

§ Rough approximation in carotenes. Content is too variable for dependable averages.

Practical Poultry Management

All-Mash Ration

Ingredients	Pounds
Yellow cornmeal	945
Ground wheat	500
Alfalfa meal (vitamin A 100,000 U.S.P. units/lb.)	40
Soybean meal (44%)	250
Fish meal	50
Meat scraps (50%)	50
Distillers' dried solubles	50
Dried whey	50
Dicalcium phosphate	25
Ground limestone	30
Salt	10
Manganese sulfate	0.5
Vitamin A oil (4500 U.S.P. units/gm.)	1
Dry vitamin D (1500 I.C.U./gm.)	1
Total	2002.5

Determining the amount of vitamin A feeding oil needed in the ration. Vitamin A is reported in U.S.P. units per gram. In feeding oil, the number of U.S.P. units per gram may range from 4000 up. In the dry forms now on the market, the U.S.P. units vary from 2400 to 20,000 per gram. The number of pounds of oil or of the dry form needed in a ton of feed is determined by finding the total U.S.P. units required to meet the need listed in Table 9. Divide this total number of units by the units per gram in the source being considered. This shows the total grams of the product needed. Since 454 grams equal 1 pound, divide the total grams by 454.

EXAMPLE

Assume 3300 U.S.P. units of vitamin A per pound are required in an all-mash ration for laying hens (Table 9), and an oil will be used having 4500 U.S.P. units per gram.

$3300 \times 2000 = 6,600,000$ total U.S.P. units required per ton.

$6,600,000 \div 4500 = 1467$ grams of the oil required per ton.

$1467 \div 454 = 3.23$ pounds of the oil required if no other ingredients supplying vitamin A are in the feed

Our sample all-mash laying ration, however, contains 945 pounds of yellow cornmeal and 40 pounds of alfalfa. These ingredients contain 1.33 and 60 milligrams of carotene per pound, respectively. Multiplying 945×1.33 and 40×60 , we have a total of 3656.85 milligrams of carotene. These must be converted to micrograms,

since 0.6 microgram of carotene (see conversion factors) equals 1 U.S.P. unit of vitamin A.

Then $3656.85 \times 1000 \div 0.6 = 6,094,750$ U.S.P. units already in the feed. From the total U.S.P. units required, deduct the number in the feed, and we have 505,250 U.S.P. units to be supplied by 4500/gm. oil.

Find the grams required, and convert the grams to pounds. $505,250 \div 4500 \div 454 = 0.25$ pound of oil. As a rule, anything less than 1 pound of oil may be called a pound.

To calculate the U.S.P. units of vitamin A contained in the final all-mash layer ration. One pound of 4500/gm. oil $= 4500 \times 454 = 2,043,000$ U.S.P. units in 2000 pounds of the feed mixture. The alfalfa and corn in the feed mixture contain 6,094,750 units. Adding, we have a total of 8,137,750 U.S.P. units of vitamin A per ton of feed, and the units per pound will be $8,137,750 \div 2000$, or 4069.

Determining the amount of the dry form of vitamin D needed in the ration. The potency of sources of vitamin D is always in terms of International Chick Units (I.C.U.). In feeding oil, the number of I.C. units per gram varies upward from 300. In sterols, or the dry form, the I.C. units per gram vary from 1500 to 3000. Reference to Table 9 shows 340 units needed per pound of all-mash feed for layers. Therefore, 340 times 2000 gives the number of units required per ton, or 680,000. If dry sterol is used, having 1500 I.C.U. per gram, then 680,000 divided by 1500 gives the number of grams needed, or 453.3. Since there are 454 grams in 1 pound, this means that approximately 1 pound of D-activated animal sterol containing 1500 units of vitamin D per gram should be added to the mash to meet requirements.

The final calculated composition of the all-mash layer ration should be not greatly less than, and may exceed somewhat, the amounts shown in Table 9 for all mash.

Check your calculated composition with the following:

Protein, per cent	16.1
Calcium, per cent	1.4 *
Phosphorus, per cent	0.78
Available phosphorus, per cent	0.56
Vitamin A, U.S.P./lb.)	4069
Vitamin D, I.C.U./lb.	340
Riboflavin, mg./lb.	1.3

* Calcium level is insufficient to meet requirements for high egg production. Free-choice feeding of oyster shell or other calcium supplement will be necessary.

8. Further feed factors

Palatability. It is well to pay considerable attention to the natural likes and dislikes of hens. Fowls are natural grain eaters, and we make use of this liking in our feeding practice. Feeds must be palatable to ensure a large consumption of them.

Hens like to eat corn, wheat, oats, cornmeal, ground oats, meat scrap, corn gluten meal, and milk. But such feeds as blood meal, rye, alfalfa meal, and linseed oil meal are less palatable.

The feeds that are most palatable are usually the most digestible, because of their greater stimulation of the digestive juices.

Wholesomeness. Musty or spoiled feeds may cause serious troubles.

Variety. Hens are creatures of habit and prefer a variety of feed. To provide variety, thus stimulating the appetite and increasing the consumption, the most satisfactory rations are made up of several kinds of feeds.

Mechanical condition. Fowls do not like very hard, extremely small, or very large kernels. They cannot consume enough of the too bulky, high-fiber feeds, because birds must have their feed in a fairly concentrated form.

Feeds that are sticky, such as linseed oil meal or flour middlings, should be limited in the ration.

Medicinal effect. Certain feeds are laxative and valuable in keeping the digestive tract open. Such feeds are linseed oil meal, milk, wheat bran, and molasses.

Effect on quality of product. Some feeds have an effect on the flavor, odor, and color of eggs or meat. Green legumes, kale, sprouted oats, and yellow cornmeal give a deep yellow color to the yolk of eggs. Wheat, oats, buckwheat, white corn, and beets tend to give a light-colored yolk.

The flavor of eggs is sometimes affected by strong feeds such as garlic. The flavor of poultry flesh may be affected by garlic.

Availability. On many farms where homegrown feeds are available, it may be practicable to utilize certain of them (page 106). In this way a ration may be compounded which may be less expensive than would be the case if homegrown feed were to be sold and something else purchased. For example, oats, buckwheat, kafir corn, and other feeds may be used more freely when they are cheaper in price and available at home or in the local market (page 107).

Cost. The best feed, of course, is the one that gives the greatest economical return. The cost of feeds differs greatly, however, in different sections of the country and at different seasons of the year. The cost of a feed is not always in proportion to its value for poultry feeding; other market demands may be governing factors in determining its market value. The demand for certain grains for human consumption may make the competitive price of these grains almost, if not quite, prohibitive. One is justified in making changes in the kinds of grain in a ration when it is economical to do so, but the feeding value of the ration should not be lowered because of cost.

The laying rations in use by successful poultrymen and recommended by various experiment stations differ. It is not likely that all conditions and factors entering into the make-up of a poultry ration would be similar, except in one locality. On certain fundamental factors all agree; on less essential factors they differ. What is entirely practicable for one may be decidedly impracticable for another. Thus we find that there is no one best ration, although fundamental requirements are becoming better standardized.

Danger in excess or deficiency of any food nutrient. If the ration is deficient, the bird may draw upon its body reserves, suffering a loss in body weight and later in production. An excess may prove injurious to the health, as the bird must either deposit or eliminate it. Some freedom of choice of feeds is desirable even with the best balanced rations.

9. The importance of vitamins and antibiotics in feeding poultry

Vitamins are absolutely essential for growth, reproduction, and maintenance of health. Without them no poultry ration is complete. Their discovery has made the poultryman less dependent upon what nature provides birds when they are outdoors. Chicks can be reared indoors quite satisfactorily, and keeping layers confined to their houses through the entire laying year is rapidly becoming a universal practice. Vitamins are found in foodstuffs in very small quantities. Whenever there is a prolonged deficiency of any of the vitamin in the food, animals usually develop a characteristic deficiency disease.

Up to the present time, many vitamins and factors have been discovered. In the practical feeding of poultry, attention should be given to four vitamins, A, D, B₁₂, and riboflavin. Other vitamins

efficient utilization of food, followed in some cases by spasmodic convulsions and death. An abnormal jerky gait is occasionally shown. The symptoms resulting from a deficiency of vitamin B₆ are apparently somewhat similar to those caused by a deficiency of vitamin B₁.

Vitamin B₁₂ is necessary for hatchability, growth and feather development. It is transmitted from the hen to the chick through the egg. It is found in built-up or compost litter and in dried manure of farm animals.

Ascorbic acid or vitamin C. Vitamin C prevents scurvy. Hens are not subject to scurvy, but the vitamin has been found in certain of the internal organs of hens. Presumably, then, hens are able to synthesize all that they require.

Vitamin E. This vitamin is required for successful reproduction in chickens. A lack of it in the feed for a prolonged time produces permanent sterility in the male and temporarily lowers hatchability in the female. It is difficult to prepare rations from the usual feeds, which do not contain adequate amounts of vitamin E. At Cornell and other stations, attempts to cure range paralysis or neurolymphomatosis by the use of vitamin E have failed. However, claims of such cures have been made for this vitamin.

Vitamin E deficiency in chicks causes nutritional encephalomalacia. This disease is occasionally found in the field. It results in difficulty in walking, loss of balance, tremors, retraction of the head, and jerking of the legs. It is sometimes called crazy chick disease. From 5 to 8 per cent of alfalfa meal may be added to chick mash should the trouble become serious in any season.

Vitamin E is very stable in feeds except in the presence of rancidity or oxidative reactions. Freshly milled products moving fairly rapidly to poultry farms reduce this possibility.

Vitamin K is not necessary for growth. Its absence prevents normal clotting of the blood. The vitamin is found in large amounts in alfalfa meal, and in meat scrap and fish meals that are not fat extracted. Hence, it is not a field problem. One per cent of dehydrated alfalfa gives protection.

Pantothenic acid is found in cane molasses, liver meal, yeast, wheat bran, and milk and its by-products. Its absence causes low hatchability, chick dermatosis, or chick pellagra, in which crusty scabs form at the corners of the mouth and the skin on the bottoms of the feet becomes thickened and cornified. The eyelids become granular and sometimes stick together.

Heuser* states, "Pantothenic acid is supplied chiefly by milk products, yeast, liver, cane molasses, peanut meal, distillers' solubles, alfalfa meal, green pasture, and grain and grain by-products." There should be little, if any, trouble when chicks or hens have access to some of these.

Biotin, choline, folic acid, and niacin (see Table 8), though important, are not significant practically, since they are found in usual feedstuffs.

Using *antibiotics* in the rations of chicks and other young animals is beneficial. They are not a substitute for good nutrition and good sanitation, but used in conjunction with these, they aid growth. How they do this is not definitely known. It may be by limiting undesirable bacteria and assisting helpful ones in the intestinal tract. Antibiotics do not serve directly as food, but they appear to assist indirectly by providing better media for desirable bacteria and by promoting a more efficient rate of body metabolism.

Young chicks are very sensitive to antibiotics, and growth is stimulated by as little as 1 to 5 grams per ton.

Aureomycin, penicillin, bacitracin, and terramycin are the antibiotics commonly used.†

Antibiotics in poultry feeding are used only with chicks. They have no effect on egg production, adult mortality, breeding, precocity, or mature body weight. Antibiotics, fed properly, are a help. When chicks are 6 weeks old, antibiotics have done most of the growth-stimulating they can do. They may be removed from the ration then with no adverse effect. They are typical examples, however, of the mistaken idea that if a little is good, more must be better, and are often fed in excess or over too long a period. They can be uneconomical and harmful to the birds. "Any time an antibiotic or a drug is used as a substitute for adequate feeding and cleanliness, that becomes misuse in its most dangerous and most costly form."‡

* *Feeding Poultry.*

† Summarized from *Cornell Feed Service*, February 1954.

‡ R. C. Klusendorf, "Antibiotics in Poultry Feed and Water—Use and Misuse," *J. Am. Vet. Med. Assoc.*, August 1954.

are essential, but are seldom in insufficient supply when the ration is adequate otherwise.

Vitamin A. A partial deficiency of this vitamin for a long time results in slow growth and increased mortality. Production is lowered. A serious deficiency of vitamin A frequently causes the eyelids of chickens to become granular and sticky, and creamy white pustules or cankers may occur in the roof of the mouth and down the esophagus. An excess deposit of urates may also be found in the kidneys, so that these organs appear nearly white in color.

The extreme form of vitamin A deficiency is sometimes called nutritional roup. It can be distinguished from ordinary colds by the absence of the customary vile odor.

When there is an excess of vitamin A in the feed over a period of time, it can be stored in the body.

A deficiency should not occur in poultry feeding. Vitamin A will be amply provided for layers and breeders if the ration contains a vitamin A feeding oil, alfalfa meal, and yellow corn.

Vitamin A is obtained by animals from carotene, which is generally abundant in feeds containing a yellow pigment called xanthophyll. The xanthophyll-bearing feeds, however, tend to darken the yolks and should be fed in limited amounts. Sources of carotene in feeds for poultry are the following:

Feeds Containing both Carotene and Xanthophyll	Feeds Containing neither Carotene nor Xanthophyll	Feed Containing Carotene, but No Xanthophyll
Green cabbage leaves	White cabbage leaves	Carrots
Yellow corn	White corn	
Alfalfa leaf meal	Mangels	
Growing green feeds, as:	Wheat	
Alfalfa	Oats	
Clover	Barley	
Grass	Buckwheat	
Oats		
Rye		
Rape		

Vitamin D. Vitamin D is required to aid the birds' proper assimilation of calcium and phosphorus. Its absence from the ration causes the bones of young chicks to fail to harden, and a deficiency disease called rickets develops within a few weeks. It is accompanied by beading of the ribs, crooked breast bones, and pli-

able, easily twisted beaks. Rickets result from the inability of the bird to deposit the proper amount of calcium and phosphorus in the bones. Vitamin D is necessary also for egg production and hatchability, and helps to prevent the occurrence of thin-shelled eggs.

The ultraviolet light of sunlight is an effective substitute for the D vitamin, as both assist the bird in utilizing the calcium. However, these ultraviolet rays do not pass through ordinary window glass. Special glazing materials can be used which allow a portion of these rays to pass through. They must be kept clean, as dirt prevents passage of ultraviolet rays. If curtain fronts are used, they should be opened on all favorable days during the winter. Even the small amount of ultraviolet light rays in the sun and atmosphere assists in strengthening egg shells.

Vitamin D is easily supplied by using vitamin D feeding oils or D-activated animal sterols.

Riboflavin is necessary for chick growth. It must be present in breeder rations to permit proper embryo growth and livability. It is required by growing chicks. Its absence causes low hatchability, slow growth, high mortality in young stock, and a leg paralysis causing chicks to walk on their hocks with the toes turning inward.

The chief sources of riboflavin for poultry feeding are milk by-products, alfalfa meal, and fermentation by-products.

Riboflavin is synthesized in built-up litter.

Other essential vitamins present under conditions of practical poultry keeping follow.

Vitamin B₁ or thiamin. A deficiency of vitamin B₁ (thiamin) in the ration results in loss of appetite and vigor, and emaciation. This deficiency disease is known as polyneuritis. Fowls in the final stage of this disease frequently will pass into violent convulsions when suddenly disturbed.

Large quantities of vitamin B₁ are found in ". . . the germ and bran of all grains as well as in yeast, alfalfa, green pasture, and milk products. Hence, it is plentifully supplied in every ordinary poultry ration and does not need to be fed in extra quantities by providing special supplements." *

Pyridoxin or vitamin B₆. The symptoms of a deficiency of this vitamin are reported to be slow growth, depressed appetite, and in-

* G. F. Heuser, *Feeding Poultry*, 2nd ed., John Wiley & Sons, New York, 1935.

References

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Maintaining Egg Production Summer and Winter

An important problem which every poultryman has to face is keeping the birds in the best physical condition and in continuous production the year around and particularly as the end of their laying year approaches during July, August, September, and October. There is a tendency, under most conditions, for production to drop during these last four months of the laying year.

Sometimes birds are culled and a large percentage removed as low producers, when the real trouble is not with the birds but with the conditions under which they are kept. Good birds will often continue to lay notwithstanding adverse conditions, but medium and poor birds are often unable to do this. Therefore, each person keeping poultry should become familiar with the causes of low production and endeavor to overcome them by having conditions favorable.

Good production during the summer and fall months adds materially to the income. Eggs are advancing in price, generally, and every additional dozen secured at this season means increased profits at the close of the poultry year.

Operations:

1. Handling the laying flock in the spring.
2. Feeding during the summer and winter.
3. Using artificial illumination in the summer.
4. Keeping up the mineral supply.
5. Providing plenty of cool, clean water.
6. Keeping the flock vermin-free.
7. Keeping the laying quarters cool in summer.
8. Breaking up broody hens.

General information:

1. The broody condition.
2. Broody records.
3. Forcing the molt.

Operations**1. Handling the laying flock in the spring**

When there are 13 to 14 hours of daylight, *artificial illumination* may be discontinued. In the northern section of the United States this is likely to be in April. Sufficient stimulation can then be



FIG. 79. Hens in permanent brooder, now in use as barracks. Same pen as Figs. 8 and 9, with stoves removed and more perches installed. Same feeders as Fig. 9.

obtained from daylight until the days shorten in the fall. While experiments indicate 13 hours of light out of the 24 is sufficient, no harmful effects from all-night lights using 15-watt lamps have been observed. In summer, hens are often eating and drinking long before dawn. The thought is that *anything* which adds to the comfort of layers and aids them in caring for their physical demands helps egg production.

In May or June many poultrymen move all or part of their laying hens to *barracks*, which may be defined as temporary quarters. For this purpose, the permanent brooder house from which all chicks were removed for range or permanent quarters may be used, or sheds, hen shelters or other convenient quarters which are available

for a few summer months. When not all the laying hens in large flocks can be moved to barracks, it may be possible to combine pens without crowding. The empty pens in the laying quarters may be made ready and the pullets moved in at any time later.

The season of hatching may change the time when the laying quarters are needed by pullets, but hens may be moved to barracks any time before July. Cooler, less crowded quarters are very desirable during July to October.

2. Feeding during the summer and winter

Very warm weather retards food intake. To encourage higher food consumption, milk or water may be fed daily on the dry mash.

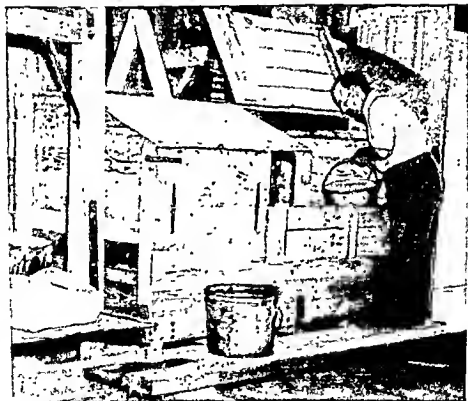


FIG. 80. A feed bin. Grain on the right and mash on the left. Note that the bin is raised above the floor as a precaution against rats. The corner of an elevator is shown at the left.

Start this in May or June. A wet mash may be mixed, or 1 quart of milk or water for each 100 birds may be spread over the dry mash in the feeders. Pellets are sometimes used to increase consumption. More grain (high energy) may be helpful.

Feeding during the winter is fully as important as in summer. Sudden cold may cause the birds to stand around and not eat. Production is affected 2 or 3 days later. On those days when the temperature drops several degrees and the birds are not consuming normally, keep the food and water intake high as explained in the preceding paragraph. Continue this extra feeding 3 to 4 days if cold weather remains, then discontinue if you wish. The layers will have become adjusted to the weather by then and do not need the extra stimulation to eat. This extra feeding may be started or stopped at will as long as the birds are adjusted to the weather.

A well-ventilated and well-insulated glass-front house has less temperature variation. Curtains should be closed each night in winter to protect against wind, storms, and, to some extent, cold.

3. Using artificial illumination in the summer

When the amount of daylight becomes less, the bird receives less stimulation and has less time to eat. About August 15 to September 1, in the northern United States, artificial illumination should be given to the flock of layers which are approaching the end of their laying year. After their rest period, continue lights on those going into their second year of production (pages 153 and 154). A more detailed discussion on the use of lights on pullets and hens, also the treatment before, during, and after the rest period, will be found in Chapter 9.

4. Keeping up the mineral supply

Good poultry husbandry requires a plentiful supply of grit and oyster shell *always* before the birds. Place shell in a 4-foot hopper and grit in at least a 1-foot container for each 100 hens.

5. Providing plenty of cool, clean water

The water supply must not be neglected, winter or summer. In summer, fresh water is necessary for the cooling effect it has upon the body, as well as for supplying the necessary moisture demanded for egg production during heavy laying. A lack of a constant supply of water may be the principal cause of a drop in production, summer or winter. Use water warmers or protect water pipes by soil heating cable during the winter.

6. Keeping the flock vermin-free

A flock of fowls may easily be thrown out of production if body lice, red mites, or other vermin gain a foothold. No trouble should be experienced if perches and nests were properly treated, but if vermin are found, treat perches as recommended (page 285).

Examine the birds for body lice. If any are found, take imme-

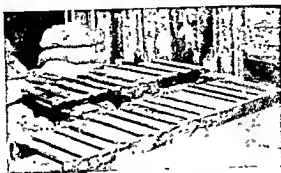


FIG. 81. Feed racks for holding sacked feed. This construction permits cats to protect the feed from rats when the bags are stacked in rows. Sides are $2" \times 6"$.

diately steps to get rid of them. (See pages 283 and 284 for a discussion of the pests and methods of combating.)

Continuous war on rats should prevail.

7. Keeping the laying quarters cool in summer

For good production, it is necessary to keep the interior of the houses cool during the summer.

* An insulated roof or ceiling helps bring about this condition. Insulated walls give still greater protection. Ventilation openings which provide ample cross air movement and which permit warm air to escape quickly are necessary. Sprinkling the litter and walls *lightly* with water will produce *evaporation* and hence a drop in temperature. Roof sprinklers, outside or inside, are of great help in very warm weather and may be drained as cooler weather approaches. On very warm days, sprinkling may be done *lightly* several times.

Excessive heat during the day or night may cause a serious slump in egg production, and sometimes death. The reason for this is clear when we consider the effect of heat on the birds. In an effort to keep their bodies cool, they spread their wings and stand with open mouths, panting. Much energy is lost in this way. Because

they cannot sweat, as do most other domestic animals, and are therefore prevented from cooling their bodies through evaporation of moisture, their normally high temperature coupled with the heat of the house makes them decidedly uncomfortable. Practically the only way they can cool themselves is to breathe rapidly and drink cold water. Hence, food consumption is very low and the natural result is a drop in production.

8. Breaking up broody hens

Broodiness is a great handicap to production in some flocks. In certain varieties and strains, a large number of birds are frequently



FIG. 82. A hand-operated elevator for moving feed, bales of litter, or crates of chickens one story. The 5' diameter wheel is easily turned, thus raising by rope and pulley the load shown. Electric hoists are advisable for large plants.

broody at one time and remain so for a considerable period. This means that many birds are out of production at all times during the summer. Unless hens are needed for hatching and to mother young chicks, they should be "broken up" as soon as possible.

During the summer an extra trip should be taken through the buildings each night, and any hens found on the nests should be confined in a broody coop. Supply these birds each day with plenty of water and mash. At feeding time in the evening of the third or

fourth day, they may be returned to the flock. The majority will be over their broodiness and will go on the roosts. Any hens that go back to the nest will be confined that evening and will remain another 3 or 4 days. For a large flock, two or three separate coops will be found useful.

General Information

1. The broody condition

Hens seldom go broody unless they have been laying. When confined immediately, they will often lay an egg or two in the broody coop. Supplying them with water and egg-making feed causes the egg yolks to resume their development and thus tends to keep the birds in laying condition, with the result that after a few days' confinement they may be released. They are likely to return to laying within 1 or 2 weeks. On the other hand, if a bird is left on the nest for several days her broody tendency increases and therefore a longer confinement is necessary. While on the nest, she goes without the necessary egg-making food and is partly nourished by absorbing the egg yolks. If a bird is opened after being broody a considerable time, the yolks are seen to have been practically absorbed. Therefore, when a hen has been broody for several days, more time is required to break up her broodiness and to develop egg yolks to the point where she will begin laying again. Under these conditions, several weeks of production may be lost.

It frequently happens that food is kept from the broody birds with the expectation that they will get over their broodiness more quickly. The lack of food means more rapid absorption of yolks within the body and hence a longer time to regain a laying condition.

2. Broody records

Birds that become broody three and four times in one season are losing too much time to be profitable. As an aid in recording the number of times a hen is broody, the following plan may be used. Secure leg bands of a certain color or number, representing broodiness. (Spiral celluloid leg bands of the same color are satisfactory.) Place one on the bird's shank each time she is found broody. In this way each hen carries her season's broody record with her. If a bird is found with two or three broody bands she

may be viewed with suspicion. Examine her carefully by means of external characters (see Chapter 16) to determine whether she should be kept or culled.

While it is true that high producers may go broody several times in a season, the poultryman should not breed from such a bird. The policy should be to breed broodiness out of the flock.

3. Forcing the molt

Birds to be used the following season as layers or breeders should be made to molt and rest some time in the late fall (page 154). As seasons of highest prices for eggs may precede this period, some poultrymen "force-molt" their birds in early summer, expecting them to complete their molt and lay during the high-price season.

However, egg production is lost during the summer when prices are rising, culs are molted along with the high producers and therefore held over when they should be marketed, and the return over a full year period may not be increased.

Results show no gain financially in producing market eggs by early forced molting. The desirable practice appears to be one which attempts to hold birds in production until October or early November, and then force molt if they are to be held over. The practice is easier and more profitable at that time. (See page 154.)

Community Survey

1. How many local poultrymen feed a moist mash or pellets in late summer to the laying flock?

2. How many use artificial lights in late summer to keep up production, and how are the lights used?

3. At what time of the year are they discontinued?

4. What system of management is used to provide laying house space when pullets are ready to be housed?

5. Are all hens sold at the end of their laying year?

6. Are some hens kept for breeders? What care do they have until eggs are needed for hatching?

7. Are some hens kept as second-year layers? Describe the care they receive until egg production starts again.

8. Are there any flocks that receive neither dry or wet mash nor pellets during the summer?

9. Compare the percentage production between flocks that receive mash and those that do not.

10. What provision is made to keep the houses cool in summer? To keep the birds vermin-free?

11. What plans are followed in handling broody hens? How would you improve on these methods?

Using Artificial Illumination

Operations:

1. Installing illumination in the poultry buildings.
2. Operating the lights.

General information:

1. Artificial illumination vs. the hen's nature.
2. The principle of artificial illumination.
3. Intensity of light.
4. Systems of wiring for artificial illumination.
5. Gasoline and kerosene lanterns.

Operations

1. Installing illumination in the poultry buildings

The lighting unit which best fulfills all the requirements is a standard 40-watt Mazda lamp. (If all-night lights are used, a 10- or 15-watt lamp may be used in place of each 40-watt lamp. The total watt-hours are not greatly different.) A cone-shaped reflector (Fig. 83) 16 inches in diameter at the base by 4 inches high, with the reflecting surface of aluminum bronze, gives the best results.



FIG. 83. The lamp and reflector. Cornell University.

How to make the reflector. In *Extension Bulletin 411*, published by Cornell University, we find these instructions for making a reflector:

The local tinner can do a much neater job than the amateur. If the tinner is to make the reflectors, it will only be necessary to furnish him the shade holders and the dimensions of the reflector, 16 inches in diameter by 4 inches high, and to instruct him to rivet or solder the shade holders to the reflectors. When the reflectors come from the tinner, wash them in a weak solution of vinegar and water, allow them to dry thoroughly, and then paint them on the inside with three coats of aluminum paint. One ounce of aluminum bronze and $\frac{1}{4}$ pint of French bronzing liquid will be sufficient for three coats on ten reflectors. The aluminum reflecting surface will not discolor and will retain its reflecting properties much better than will white enamel paint.

Height above the floor. The best distribution of light is obtained when the lighting units with the reflectors are located 6 feet



FIG. 84. Lighting units, with proper reflectors placed 10' apart, provide correct conditions Cornell University.

from the floor, 10 feet apart, and along a line midway between the front of the house and the front of the droppings board.

Determining the number of lighting units necessary per pen. To find the number of lighting units that will be required for a

given size of pen, divide the number of square feet of floor area by 200. The nearest whole number will be the number of units required. The shape of pen matters little. Space the units to distribute the light as evenly as possible over the area, including floor, feeders, waterers, and roosts.

EXAMPLES

$$\begin{array}{l} \text{Large pen: } 45 \text{ ft.} \times 44.5 \text{ ft.} = 2002.5 \text{ sq. ft.} \\ \quad \quad \quad 32 \text{ ft.} \times 22 \text{ ft.} = 704 \text{ sq. ft.} \end{array}$$

$$\text{Total } 2706.5 \text{ sq. ft.}$$

$$2706.5 \div 200 = 14$$

Thus, fourteen lighting units will be required.

$$\begin{array}{l} \text{For a } 20 \times 20\text{-ft. pen: } 20 \text{ ft.} \times 20 \text{ ft.} = 400 \text{ sq. ft.} \\ \quad \quad \quad 400 \div 200 = 2 \end{array}$$

Thus, two lighting units will be required. Place these units 10 feet apart and 5 feet from either end.

If the poultry house is partitioned into pens, figure each pen separately.

2. Operating the lights

The lights should be operated in accordance with the principles laid down in the following paragraphs.

Length of day. Thirteen to 14 hours of daylight and artificial light provide a desirable lighting plan. However, all-night lights, using a smaller lamp (page 147), are satisfactory.

General rules. The following rules for the use of artificial illumination on a flock of layers will be found useful.

Part-time lighting. (1) Turn the lights on, by hand or automatically, at 5 A.M. (2) Turn the lights off after daylight arrives. (3) Turn the lights on at twilight. (4) Turn the lights off at approximately 6 or 7 P.M.

When this procedure is used, it should be followed regularly throughout the season of illumination. The exact time of day that the lights should be turned on in the late afternoon (3) will vary from day to day according to the season.

It is desirable, but not absolutely necessary, to install a dimming device in order to enable the birds to go to roost of their own

accord. If the birds are fed in litter, they should have 1 to 1½ hours of feeding time before the lights are turned off at 6 or 7 P.M.

For a few nights, the attendant should see that the birds are not allowed to remain on the window sills or interior fixtures. This precaution will usually result in fixing the roosting habit.

All-night lighting. Turn the light on any time in the evening and off when convenient in the morning. An automatic device will save current in the spring when daylight begins early.

Determining the season to start lights. The time of the year to start artificial illumination will depend upon: first, the latitude in which the poultry plant is located; and second, the age, the maturity, the laying and physical conditions of the birds. There is no one best time for all flocks.

Starting lights. When commencing to use lights in the fall of the year, full lighting may be given immediately. Once started, lights should be continued without interruption; otherwise a slump in production and a molt may occur.

Taking the lights off in the spring. Artificial illumination should be continued with commercial laying and breeding flocks until such time as the normal length of day is 13 to 14 hours. At this time the lights may be gradually discontinued until daylight takes the place of artificial light.

All-night lights. Half the lamps in each pen may be discontinued first, and the others a month or six weeks later or just before the longest days of the year. All-night lights may be continued the year around, thus relieving the operator of attempting to determine when stimulation from light is most needed.

Determining the time of day to use lights. The time of day when lights should be used will depend largely upon the source of light, i.e., commercial electric current supplied by power plants, current generated by a private or independent electric lighting unit, or lanterns. Whether the lights are given at twilight, later in the evening with an evening lunch, in the morning, both evening and morning, or all night is of less consequence than the total number of hours of daylight and artificial illumination the birds receive in 24 hours.

The use of lights at any particular time of the day is primarily a question of convenience for the operator. Each method of using lights has its particular advantage.

(1) *Early evening* lights are convenient in many cases, since they enable the operator to include the feeding and lighting among the early evening chores.

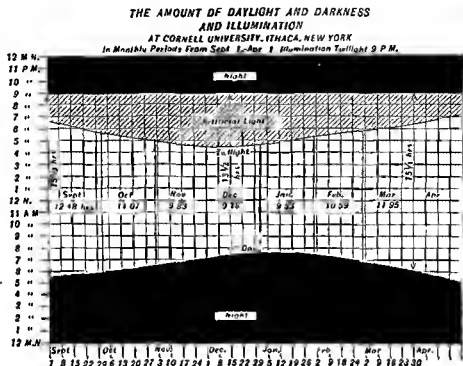


FIG. 85. Lights to a certain hour at night only provide an uneven length of day. Note the distance from dawn until the evening hour when the lights are turned off. A different length of day from day to day is not satisfactory.

(2) *Morning* lights cause the birds to leave the perches quickly and start their long day early. Morning light may be turned on by an automatic device. Dimmers are unnecessary.

(3) Giving the light *partly at night and partly in the morning* has the great advantage of enabling the operator to overcome the changing period of twilight and dawn, thus giving the birds a uniform day and a uniform night throughout the entire lighting season (Fig. 87).

(4) The *all-night* method comes closest to meeting the needs of individual birds. The caretaker can do his work in the poultry pens at will. Hens go to roost about the normal time whether lights are on or not. A few may busy themselves about the pen the first half of the night. Starting at 1 to 3 A.M. larger numbers leave the perches. No bird is compelled to remain roosting longer than she desires.

Practical Poultry Management

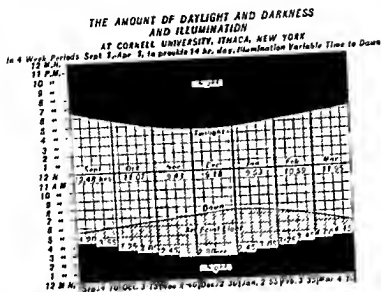


FIG. 86. Lights may be used in the morning only, but to secure an even length of day they must be turned on correspondingly earlier or later as the day shortens or lengthens. This is confusing and may result in an irregular length of day.

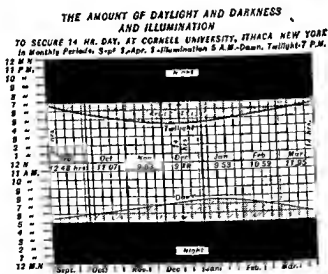


FIG. 87. Lights in the morning from a certain regular hour until daylight, and from twilight until a certain fixed hour, provide an even length of day during the winter and prevent a constant changing of hours for eating and sleeping, for the birds.

Using lights on pullets. The time to start lights depends on the season hatched and the rate of maturity. Pullets continue to grow physically several weeks or months after production starts. Food must be ample to permit both.

Season hatched. Pullets starting normally to lay during April or May, approximately, will increase production for several weeks under the stimulation of the increasing length of day and without further stimulation of artificial light.

Start lights on such pullets when production appears to be reaching its peak and continue using them. By this time any slow-maturing pullets worth keeping in the flock should have reached sufficient body size and started comb development, and may be placed with the main flock as they are now ready for extra light stimulation.

Any very small, underdeveloped pullets should have been culled.

Pullets hatched to reach sexual maturity after July are handicapped by the constantly decreasing length of day and should receive lights when the combs start to show red to assist them in developing both physically and sexually. Once having turned on the lights, continue them.

Rate of maturity. Pullets that are much slower to develop than the main flock should be left by themselves for a while longer. Otherwise, because they are usually timid and likely to remain on the perches, they will be deprived of food and water. As they develop, put them in with the main flock.

Continuing fall production by the use of lights on hens. During late summer and fall, the usual flock of hens near the end of their first laying year is made up of individuals which may differ widely in their physical condition and laying capacity.

(1) *Start lights* as the end of the flock's laying year approaches. As the days become shorter in late summer, unless all-night lights are used the year around, lights may be started on the laying flocks, keeping a 13- to 14-hour day. This practice holds the birds in production longer in the fall, at a time when egg prices are usually advancing.

(2) *Cull.* The hens that cease production before September or October and have laid less than 12 months at the end of their first laying year should normally be culled.

(3) *Desirable layers.* Birds that have laid continuously for 13 months or more by September or October may be rested and kept for a second laying year, or they may be culled and sold or used.

If they are to be held as layers for a second year and are out of production, they should be given full opportunity to recover their plumage and regain their weight. *To do this*, place them by themselves in separate pens, without artificial illumination. Recovery is indicated by the return of a normal amount of color pigment in the beak, plumage, and skin. Resume artificial illumination 5 to 6 weeks after production ceases, at which time their new plumage will be growing well. They should respond quickly with a production of approximately 50 per cent or more and should maintain it with only slight variation, under correct methods of feeding, through the winter.

Birds still laying by November at the end of their first laying year should at that time be forced out of production and into a rest period of several weeks if they are to be held for a second year of production. When this is done in early November, the new feathers will grow in far enough to protect the birds from the really cold weather later. *In sections where cold weather approaches earlier, the date of molt should be advanced.*

How to force birds out of production. Turn off the lights abruptly. Take the mash and grain away. Give no water for 1 day, and then only $\frac{1}{2}$ day for 3 or 4 days. As soon as production has practically stopped and the birds are molting, give grain, mash, and water in the usual manner. Five to 6 weeks from the time production ceased, give artificial illumination in the usual manner. The new plumage should then be well started.

From the above it will be seen that artificial illumination provides a powerful controlling factor in starting or in stopping production.

Using artificial illumination in the second year of production. Artificial illumination, it should be understood, with all of its power in controlling production, cannot create a condition which will enable birds to lay uninterruptedly from one laying period into the next without a rest.

Two methods of managing birds through the winter are used: first, the *forced rest* previously described; second, *continuous lighting*. In the latter method, management for production continues through the winter and the following year. Individual birds will cease production for a time, rest, molt, and resume production.

When birds are not to be held as second-year producers, but are to be culled as they cease to lay during the second fall, winter, or spring, continuous lighting should be practiced to get all the eggs possible

Using lights on males. Whatever tends to cause the development of eggs in the female results in more active mating and fertilization of eggs on the part of the male. Males may give better fertility when placed under lights about 3 weeks before the breeding season.

General Information

1. Artificial illumination vs. the hen's nature

The hen is by nature a native of a tropical country, where the nights and the days are of essentially equal length and the temperature permits fowls to live in the open air the year round. In domestication in the North, she is kept under unnatural conditions.

In all the centuries during which the hen has been under domestication, she has adapted herself to her environment—to cold climates, unnatural food, and close confinement—by changing her habits, rather than by changing her physical nature. Not being able to migrate to more favorable environments as some of her bird relatives do when the days shorten and the amount of light lessens, she simply makes the best of it. She produces fewer eggs unless her progressive owner gives her the normal daylight conditions of spring during the dark winter months.

The owner can accomplish essentially the same result either by transferring the hens in the fall of the year to a more congenial southern climate where the hours of daylight are longer and the nights are shorter, as in Florida, or by doing what is less expensive and more practicable—by providing light to duplicate the normal spring day in the North or winter day in the South.

The hens can then see to eat and work as they desire. Food and water, while not the primary motivating influences, are efficient co-workers with artificial illumination. If they are not supplied in quantity, the stimulating effect of light may result disastrously, by causing loss in weight and eventually in production.

2. The principle of artificial illumination

Light increases food consumption indirectly. Certain rays of light stimulate, largely through the eye, the hypophysis or pituitary gland near the base of the skull. This gland, under this stimulation, liberates into the blood circulation a material called a *hormone* (one of several), which in turn stimulates the ovaries of the bird, causing increasing development of the egg yolks.

The rapid growth of egg yolks draws heavily on the reserve food

supply, and the demand for and the consumption of food is increased as larger numbers of eggs are produced.

Birds bred for many years for high production are less affected by light, possibly because the availability and supply of the particular hormone are likewise hereditary.

But the proper use of artificial illumination is a wonderful aid, even under these conditions. Its use to help prevent slumps in production during very cold weather and to start birds into production quickly after the rest period are examples.

However, the most marked results are seen on late-maturing pullets and on hens if and when held for their second laying year.

Whetham * states that "high producers are less affected by variations in the daily light period, probably because of an hereditary high level of the hormone" involved, and further that light raises "the production of the poorer . . . toward that of the best," presumably by stimulating an increased secretion of the necessary hormone until the amount more nearly approaches the amount already available to the higher producers.

3. Intensity of light

The use of artificial illumination is closely associated with the method of feeding. The birds should go to roost with full crops. Hence, the influence of the method of lighting on the efficiency with which the birds can eat grain or all mash at night and retire with full crops must be considered.

If grain is fed in the litter after dark, a greater intensity of light is needed than for feeding by the trough or the free-choice method, so that the birds will see the kernels of grain.

4. Systems of wiring for artificial illumination

Simple switch system. Where only *morning light* is needed, the simple system diagramed in Fig. 88 is in common use. This circuit is one without a dimming device, requiring only a switch for turning the lights on and off. Time switches are on the market for this purpose. Many ingenious poultrymen have connected an ordinary alarm clock with a simple switch for turning the lights on or off.

Systems for dimming light. Wiring diagrams for two methods of dimming lights are shown in Figs. 89 and 90.

The resistance-unit system. The resistance-unit system (Fig. 89) makes use of a fixed resistance R instead of a variable resist-

* E. O. Whetham, *Poultry Sci.*, November 1933, p. 399.

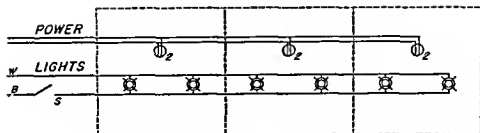


FIG. 88. Wiring diagram for morning light. This system of wiring is controlled by a switch and is the same as any house lighting circuit. *W*, white wire; *B*, black wire; *S*, switch that, when closed, permits electric current to pass from one wire to the other through the light bulb; 2, outlets. Cornell University.

ance. The time switch *S* turns the lights on bright by moving the knife arm up to contact the main circuit. To dim the lights, the knife arm is moved down to throw the resistance *R* in series with the lights. To turn the lights off, the knife arm swings up to the central, or off, position as shown in Fig. 89. This system does not lend

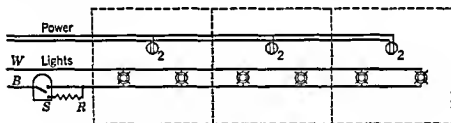


FIG. 89. The resistance-unit system. Cornell University.

itself readily to any subsequent rearrangement, because if the number of lights were increased or decreased, the resistance unit also would have to be changed, in order to give the desired intensity of light. This system is seldom used.

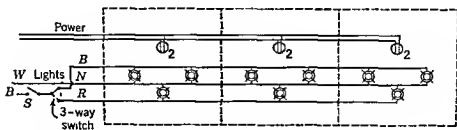


FIG. 90. The two-circuit system. Cornell University.

The two-circuit system. The two-circuit system consists of two lighting circuits (Fig. 90) with a common wire marked *W* (white)

or *N* (neutral), or two separate circuits of two wires each. For this system, three wires are run the length of the house. Across *N* or *W* and *B* are the standard 40-watt lamps for the bright light, and across *N* or *W* and *R* (red wire) are the small 10-watt lamps for the dim light, one for every 400 square feet of floor area. To turn the bright lights on, the switch arm is moved up to contact the *BN* circuit. When the dim lights are required, the switch arm is moved down to contact the *RN* circuit. A standard three-way switch can be used for this purpose. A single-pole switch should be installed in the live wire ahead of the three-way switch, as shown in the drawing, to provide a means of turning off all lights.

This system may be operated by hand or by a time clock, and it permits any method of handling birds under artificial light.

5. Gasoline and kerosene lanterns

As a last resort, gasoline and kerosene lanterns offer a possible, but dangerous, source of illumination. Their effectiveness is greater if a reflector is used.

Community Survey

Visit as many poultrymen as possible, and by means of inquiring and by observation, find:

1. The methods of supplying light, such as lanterns, home generating plant, city supply, etc.
2. What percentage of the poultry keepers are using lights.
3. What kinds of reflectors for electric lights are used.
4. During what hours lights are used.
5. The number of lights carried.
6. The watts or candle-power used per hour of illumination.
7. The total watts or candle-power used per day.
8. The methods of wiring for electric lights. Diagram these.
9. How far above the floor the different lights are located.
10. What, in the minds of the poultrymen of the community, are the chief benefits derived from lights.
11. What the cost of lights is for the year.
12. What percentage of the poultry keepers are using lights on breeders.
13. How lights are used on pullets. On hens.

Reference

Wright, F. B., *Electricity in the Home and on the Farm*, 3rd ed., John Wiley & Sons, New York, 1950.

Preparing Eggs for Market *

The poultryman has a peculiar advantage, as compared with the producer of milk, for example, in that the hen delivers her product in such convenient form. She gives him the semifluid edible portion of the egg in a convenient size for table use, in a special sealed

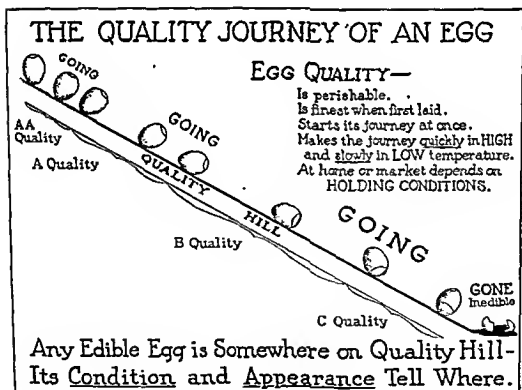


FIG. 91. Once the egg is laid, the journey starts. Prepared by H. E. Botsford.

* For a discussion of distributors, methods of marketing, and the operation of cooperatives, auctions, and other receivers, the reader is referred to *Marketing Poultry Products*, 4th ed., by Benjamin, Pierce, and Termohlen, published by John Wiley & Sons, New York, 1919.

package wrapped with two shell membranes, sealed within the egg shell and untouched by human hands.

All the skill, expense, hazard, and thought given to the enterprise culminate in the production of the egg or meat. The aim, therefore, should be to preserve the quality of the finished product and thereby secure a commensurate price.

Correct care should be given the eggs before and during shipment, in order that they may be as near the original quality as possible upon arrival at the market.

Operations:

1. Producing clean eggs.
2. Gathering the eggs.
3. Holding market eggs.
4. Cleaning market eggs.
5. Sorting market eggs.
6. Candling market eggs.
7. Packing eggs for shipment.
8. Detecting abnormal shell conditions and internal defects.

General information:

1. The 30-dozen egg case.
2. U. S. standards for quality of individual shell eggs.
3. U. S. consumer grades of eggs.
4. Factors affecting the interior quality of eggs.
5. Why eggs lose quality.
6. Home preservation of eggs.

Operations

1. Producing clean eggs

Dirty eggs are an expense to someone. Washing them takes time and, unless correctly done, may cause serious interior deterioration. If they are shipped dirty to market, they will bring a lower price than clean eggs of the same size and interior quality.

Reduce the number of dirty eggs by observing these rules:

- (1) Construct the nests 7 to 8 inches deep inside and allow another 7 inches or more to the ceiling. (Figs. 48 and 54).
- (2) Provide 4 to 5 inches of fine, clean, fluffy, and absorbent nesting material, such as shavings, oat, buckwheat, or peanut hulls.
- (3) Keep the nest material clean and remove any that is dirtied by broken eggs or manure.
- (4) Do not let the birds roost on the nests at night.

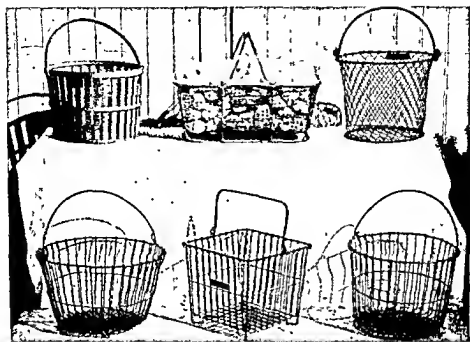


FIG. 92. Types of baskets used for gathering eggs.

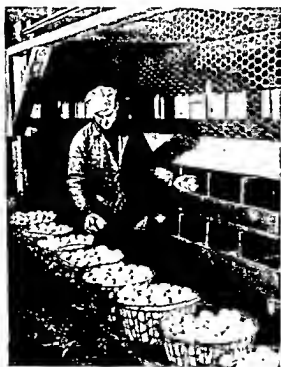


FIG. 93. Good use for a track and car.

- (5) Allow 1 linear foot of nesting space for each 5 or 6 hens, to avoid undue crowding and egg breakage.
- (6) Keep the litter dry.
- (7) Do not let storms drive into the house.

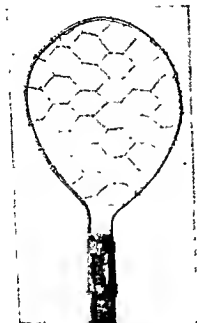


FIG. 94. A handy homemade device for getting eggs from out-of-the-way places.

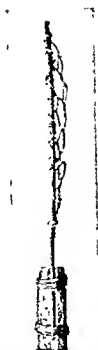


FIG. 95 Side view of the egg-retrieving device. Note the bulge in the wire.

- (8) Avoid overcrowding. Allow 3 square feet of floor space, or more, to each bird.
- (9) Clean up and prevent wet places near the water receptacles.

2. Gathering the eggs

Use strong baskets of woven or welded wire or pails with sides perforated with $\frac{1}{2}$ or $\frac{3}{4}$ -inch holes (Fig. 92). Eggs may be left in the baskets or pails to cool, or spread on raised wire trays. Containers with flexible sides will crack the eggs and should be avoided. Wooden baskets, if strong, are satisfactory, but they should be of open construction to permit cooling.

Collect eggs three or four times daily. The time to collect may vary with the number laid. During very warm or very cold weather and when the birds are laying heavily, collect at approximately 8:30 to 9:00, 10:00 to 10:30, 11:30 to 2:30, and at night, to prevent the eggs from becoming heated, frozen, broken, or dirty.

Eggs should be cooled quickly after they are laid. They contain carbon dioxide (CO_2), a beneficial gas that helps to maintain quality. This gas is lost more easily at room temperatures or above; hence, cooling eggs retards the loss of CO_2 , but hastens the heat loss, both of which are apparently beneficial to eggs.

3. Holding market eggs

Take the pails or baskets of eggs at once to a clean cellar or room, free of any musty odor. Do not leave eggs in the kitchen, pantry, or other room until the dirties are sorted out. A uniform temperature between 45 and 60 degrees F., good ventilation, and 75 to 80 per cent relative humidity are desirable where eggs are held. *Eggs, like milk, lose quality rapidly under poor holding conditions. Cooling and high humidity retard deterioration; warmth or jarring the eggs hastens it.* Eggs should cool for 12 hours in the pails before being packed in the cases. Today's eggs should be packed tomorrow. The cases should have been in the cellar to keep them cool and moist. Quickly cooled eggs, packed in a cool, moist case and held in a cool, moist cellar until they are shipped, should reach

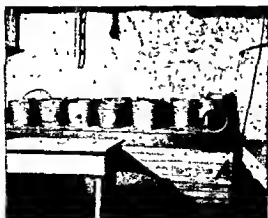


FIG. 96. Circulating air is used to cool eggs quickly in this egg room. An electric fan in the end at A drives air into the wooden chute, through holes in the top, and into and through the wire-bottomed pails. A fine mist of water is sprayed constantly into the room, maintaining a relative humidity of 85 to 90 per cent. Excellent quality eggs reach the market from this farm.

the market in excellent condition. The fillers and flats hold the cold in but keep circulating air out, which is desirable.

Egg rooms. *Still-air cooling* occurs best in a room built underground with a room or building above. An earth floor allows the soil moisture to enter the room. Water may be added to the floor if needed. Such a room should have outside walls of stone or concrete with insulated partitions separating it from the main cellar. It should be placed on the north or northeast side of the cellar and should have near the ceiling at least one window which may be used for ventilation. A slatted rack on the floor will keep the baskets and cases off the ground.



FIG. 97. Water is sprayed through wire into excelsior. Air is drawn into the building by a large electric fan inside, thus cooling eggs and raising the humidity.

Shrubby or trees which protect the building will assist in

keeping the egg room cool and moist.

Circulating-air cooling is more rapid and can be satisfactorily used when electricity is available (Figs. 96 and 97).

Excessive use of the fan directly on the eggs should be avoided to prevent possible evaporation of the eggs. Operating the fan from $\frac{3}{4}$ to $1\frac{1}{2}$ hours should suffice in an arrangement such as that shown in Fig. 96.

For cooling large numbers of eggs or a large room area, in the absence of special cooling equipment, much good has resulted by hanging sheets of burlap on four sides and keeping the burlap wet by water dripping from small holes in pipes placed just above it. A large fan causes faster evaporation from the burlap and reduces the temperature inside the room.

Size of egg room. Fifty-two marketable eggs produced daily means 1 case to ship weekly. For a flock of 2000 to 2500 layers, provide a room approximately 12 to 15 feet long by 8 to 10 feet wide for the cool room where eggs will be held in pails and in crates and where at least 1 week's supply of empty crates, flats, and fillers may be stored. A second room of similar size is needed for washing and sizing machines and for packing.

4. Cleaning market eggs

Eggs may be sold clean or as gathered. If they are clean, their money value is higher. Most poultrymen clean the soiled eggs, and the method of cleaning is extremely important. It is well to remember:

(1) Eggs produced clean are best for either quick consumption or storage.

(2) Quality loss is very low in eggs produced clean if they are handled and held correctly.

(3) Cleaning requires extra labor and is costly.

(4) Soiled eggs may mean bacteria which are harmful to egg quality.

(5) Bacteria enter the egg through the shell in the presence of moisture.

(6) To prevent harmful action the bacteria must be washed away or destroyed as soon as practicable after the egg is laid.

(7) Any solution in which eggs are immersed for washing should be warmer than the eggs, or from 110 to 130 degrees F.

(8) Any machinery used for cleaning eggs must be kept clean lest eggs become contaminated while being washed. Follow directions of the manufacturer for cleaning.

In general, three methods of cleaning eggs are in use.

(1) *Small lots* of slightly soiled eggs may be cleaned with a sandpaper cleaner or washed by hand under warm, running tap water.

(2) *Thermostabilization* consists of "immersing shell eggs in water long enough to heat them throughout but regulating the temperature and time to avoid any perceptible coagulation." * Results in 1952, which appeared to substantiate those earlier, showed that soiled eggs washed in tap water and then immersed for 3 minutes, 5 minutes or 15 minutes in water at 145, 140, and 130 degrees F., respectively, reduced loss in eggs held in storage for 5½ months during 1952, lower than any other method tried and even lower than clean eggs stored at the same time. It also showed that, up to 96 hours, the time of washing after laying is less important when eggs are thermostabilized, since bacteria inside the shell, if any, are then destroyed.

* E. M. Funk, James Forward, and Martha Lorah, "Minimizing Spoilage in Shell Eggs by Thermostabilization," *Poultry Sci.*, May 1954, p. 532.



A



B



C

FIG. 98. Sanitizing eggs. A. Sanitizing mixture is prepared and set in operation. The pail which contains eggs just gathered is immersed in the water. B. Two washers employed; note sizing machine in the background. C. Washed eggs in the original gathering baskets are set away to cool, later to be sized.

(3) *Sanitizing* is a recently developed method for cleaning eggs and at the same time killing bacteria that induce spoilage. It is practical with several types of cleaning machines. A list of accepted cleaner-sanitizers can be secured from Neppco.*

Egg washers used in sanitizing must be kept clean, and a new solution should be mixed for each washing. Use water heated from 110 to 130 degrees F., sanitize as soon as possible after collecting, taking not longer than 3 minutes for the washing process, and dry the eggs promptly. (See Fig. 98.)

Empty and clean the equipment after each washing and follow the directions given on the label for the proper use of the sanitizer.

When sanitizing is done strictly according to directions, it appears safe and more economical to clean and sanitize all eggs, both clean and dirty. Sanitizers for either hard or soft water are available; secure the correct one. One ounce in 3 gallons of warm water will do the job for 15 dozens of eggs.

Bureaus of markets and other organizations believe this may be an effective solution to the washed-egg problem. As with many poultry operations, only the producer who is careful and watchful of details in producing and cleaning eggs will be successful. Sanitizing is not a guarantee against filthy methods in handling eggs. "Washing is no substitute for cleanliness in production or handling. It can do you and your industry great harm if not done right. If you can't or won't wash eggs right—don't do it." †

5. Sorting market eggs

Eggs to be sold to distant or local consumers or to a dealer who pays on a quality basis must be well packed, and it may be necessary to sort them for size, shape, color, and shell condition. The operation of sorting the number of eggs produced on a small plant or farm may be done at one handling, with a small egg scale nearby. Machines which sort automatically into several sizes are used on larger poultry farms (Fig. 100).

A case should be filled with eggs of the same size. If eggs in a single case are of different sizes, pack each size in a separate filler, lay a card on top of the filler denoting number and size, and record also on the outside of the crate.

* Northeastern Poultry Producers Council, Inc., 10 Rutgers Place, Trenton 8, New Jersey.

† *Grading Eggs, a Manual for Egg Grading Schools*, Northeastern Poultry Producers Council, Trenton, N. J.



FIG. 99. Cleaning and sorting eggs on a Connecticut farm. *A.* Machine washes eggs and transports them around corner (left) to the sizing machine. *B.* Sizing machine.



FIG. 100. Machine for sizing eggs. Eggs are moved along until they tip the scale on which they are deposited.

Many flock owners, particularly small flock owners selling to hucksters, egg dealers, country stores, and the like, do not sort their eggs for size. This is not to be recommended as a commercial practice.

The size of market eggs is usually determined by weight per individual egg, per dozen, or per 30-dozen crate. The size is often estimated by the eye as the eggs are handled, and then checked by weighing a dozen or a case to determine the actual weight.

Market eggs vary in size from about $1\frac{1}{4}$ to $2\frac{1}{2}$ ounces each. Smaller or larger eggs than these are usually not marketed in large numbers.

Eggs are sorted into large, medium, pullets, and peewees. Jumbos and extra large are often sold as such. Table 12 shows the weights used in several markets.

Table 12. U. S. Weight Classes for U. S. Consumer Grades for Shell Eggs

(October 1955)

Size or Weight Class	Minimum Net Weight per Dozen, oz.	Minimum Net Weight per 30 Dozen, lb.	Minimum Weight ¹ for Individual Eggs at Rate per Dozen, oz.
Jumbo	30	56	29
Extra large	27	50½	26
Large	24	45	23
Medium	21	39½	20
Small or pullets	18	34	17
Peewee	15	28	..

¹ Minimum weights listed for individual eggs at the rate per dozen are permitted in various size classes only to the extent that they will not reduce the net weight per dozen below the required minimum, with thorough consideration given to variable weight of individual eggs and variable efficiency of graders and scales, which should be maintained on a uniform and accurate basis.

Shape. Long or wide eggs should be eliminated from a shipment, or packed near the center partition in the top fillers if wood cases are used. To prevent egg breakage, it may be necessary to build up the ends of the wood case with $\frac{1}{4}$ to $\frac{3}{8}$ -inch strips before nailing the top. Modern fiberboard case dimensions are larger and help reduce breakage. Slight ridges or moderate roughness in the shell are not sufficient to exclude eggs from a quality.

Color. Certain markets prefer white-shelled eggs; others prefer brown. It is well to cater to these preferences. Shell color has little to do with the interior quality of eggs.

Shell condition. Thin-shelled or very rough-shelled eggs may break easily in shipment. It is better to sell them locally or use them in the home.

Checks or leakers. Bakeries will often use these eggs, but it is better to use small supplies of them at home or dispose of them to local consumers. Many states prohibit the sale of leakers under consumer grades. Checks are often sold as cracked eggs.

6. Candling market eggs

Candling market eggs is a study of lights and shadows cast by the various parts inside the egg. Candling is quite similar to an X-ray picture. In much the same manner as a physician would interpret an X-ray picture, the experienced candler of eggs interprets the picture of the shadows cast when the egg is held before a light. By candling, the interior quality of eggs is determined.

To candle an egg is to hold it in front of a light shining through an opening and into the egg. Candling should be done in a darkened room or candling booth. The egg is held large end up, at a 45-degree angle (Fig. 101). Both air cell and yolk shadow can then be seen. The position of the yolk is determined by examining the yolk shadow as the contents are set whirling by a quick turn of the wrist and again after the contents have come to rest.

Use a 40-watt or 60-watt light. A convenient bench under the candling apparatus facilitates the rapid handling of eggs. Many satisfactory candling devices are available on the market, but a tinsmith can make one (Fig. 102).

Whether candling should be done by a producer depends upon his outlet. It is best to candle for a high-class retail trade and remove any eggs with poor interior quality, including blood and meat spots.

All eggs passing through ordinary marketing channels are candled somewhere before being retailed to the consumer.

What one sees before the candle. As a white-shelled egg is held before the candle, the egg as a whole may appear pinkish yellow. Looking closely at the upper end, one can see the air cell, its size dependent on the amount of evaporation that has occurred. (When first laid, an egg has no air cell.) The yolk appears as a diffused shadow, its location and prominence dependent on the strength of the albumen.

A dark spot usually follows the yolk shadow as it turns when the egg is twirled. This spot is one of the two chalazae. It is sometimes confused with a meat spot. However, a crescent-shaped light area follows the chalazae and is a reflection of light in the albumen of which the chalazae consist.



FIG. 101. Candling eggs. Note the position of the egg, the pail in which eggs are gathered, and the case for the candled eggs.



FIG. 102. A candling device that can be slipped on to the center partition of an egg case or piece of similar size. Two persons can work on opposite sides.

The area at the base of the air cell may or may not be firm around the air space.

A brown-shelled egg looks similar, but the shell gives the contents a darker shadow. Until one has had considerable experience in candling, it is sometimes more difficult to determine the quality of brown-shelled eggs.

When the egg is kept under unfavorable conditions, the albumen becomes more watery, making the yolk shadow more prominent and its position changed. The air cell may be larger and perhaps loosened.

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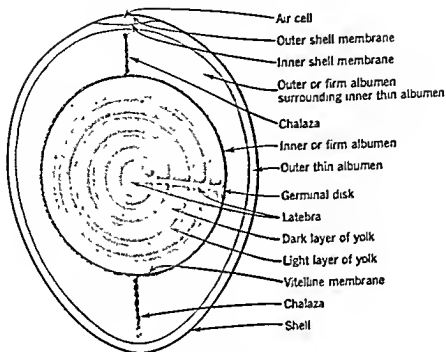


FIG. 103. Cross section of an egg.

7. Packing eggs for shipment

If eggs are to be sold locally at retail, they may be delivered in pails, baskets, or cartons holding one dozen each. The carton is usually best, as it holds the eggs securely and adds to the attractiveness and convenience of the package. By an interesting new method developed by Professor L. B. Darrah of Cornell University, eggs

may be retailed broken out in 12-compartment transparent plastic packages, each egg in full view.

For shipping to outside points, the standard 30-dozen case is best.

When packing eggs, one should see that the top layer is typical of the whole package. Eggs should be packed with the large end up because the air cells are then on top with the heavier parts below.

If the air cell is on the bottom, it is constantly pounded by the albumen, and this may result in loose and weakened air cells and broken-down albumen.



FIG. 104. A case of eggs well sorted for size and packed for market

Packing with cup flats. Place one flat on the bottom, cups up. Then alternate fillers and flats to the top of the case. Place one flat on top of the pack, cups down. Five fillers are required on each side. If a wood case is used, the top is laid on and nailed with four nails in each end. Never nail the top in the center.

The fiberboard case is growing in popularity, and is packed in the same manner as the wood case.

Packing with filler flats. See F'g. 105.

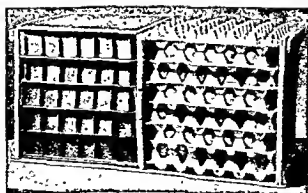
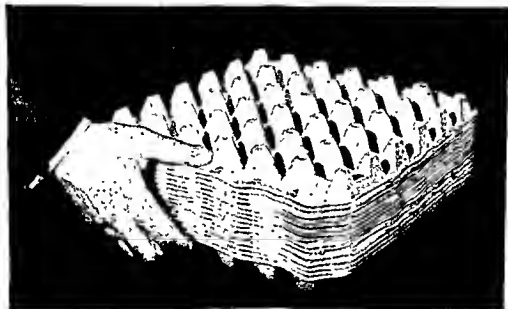


FIG. 105. The Keyes Filler-Flat, originated in the early 1930's by the Keyes Fibre Company, Inc., 420 Lexington Ave., New York City.

8. Detecting abnormal shell conditions and internal defects

(See pages 179 to 181 under "Explanation of Terms.")

As the egg is twirled before the candle, abnormalities will occasionally be detected.

Blood spots appear as red spots attached to the yolk. They differ from an embryo, as there are no radiating blood vessels. Blood spots are usually caused by the rupture of a blood vessel inside the yolk sac, or a follicle or a blood vessel is broken when the sac splits and lets the yolk drop into the oviduct. The spot is deposited on the yolk before the albumen is laid on. (See Chapter 24 for the formation of an egg.) The *U. S. Standards for Quality of Individual Eggs* permit small blood spots (less than $\frac{1}{8}$ inch in diameter) in C quality eggs, and a dozen U. S. Grade C eggs may contain a small blood spot in each egg. Whether they can be sold at retail in a state depends on the law in that state. Not all states have adopted the U. S. grades and quality standards. A small spot does not injure the egg for food. Eggs having a spot or spots which, together, are larger than $\frac{1}{8}$ inch in diameter are classed inedible. In the home, however, these spots may be removed and the egg used. A small blood spot on the yolk does no actual harm.

Bloody eggs give the albumen a red tint throughout. This may be due to blood oozing from a large blood spot, or a diseased or injured condition of the oviduct, causing blood to be exuded with the egg white while the albumen is being laid on. Bloody eggs are less common than eggs with blood spots and are classed as inedible.

Meat spots appear floating in the egg white or albumen, either entirely free or attached to the chalazae. The floating particles vary in size and color. They may be portions of the walls of the oviduct or abnormal growths of tissue which develop in the oviduct and are later dislodged when an egg passes through. Meat spots may vary from white to dark brown. After the spot has been removed, the egg is suitable for food. In the U. S. or state standards for quality, eggs showing meat spots are classed as inedible if the spots are larger than $\frac{1}{8}$ inch in diameter.

Multiple-yolk eggs. Eggs with two yolks are very common and can be detected easily by the two distinct shadows seen while candling. Often, but not always, they are accompanied by an increased size of the egg. Three and even four yolks are occasionally found in one egg shell. These eggs are usable and salable in their size and weight class. Pullets coming into production often produce multiple-yolk eggs.

Body checks. A healed-over shell cracked in the body.

Blind checks are hairline cracks in the shell, difficult to see except by candling, and are classed "checks."

Many other abnormalities occur, but those mentioned are the most common. It is well to break open eggs which appear unusual in any particular, and become familiar with the cause. This practice aids the candler in detecting a similar case at another time.

General Information

1. The 30-dozen egg case

The 30-dozen egg case has become the standard shipping package on this continent (Fig. 104). The specifications in this section are taken from *Recommended Specifications for Standard Packages and Packs of Shell Eggs*, Production and Marketing Admin., Poultry Branch, USDA, Washington, D. C., August 1950.

Types of wood. Egg cases for domestic use are usually made of veneers or solid woods.

A regular (domestic) 30-dozen *veneer egg case* is a case with the tops, bottoms, and sides made of veneer and the ends and center made of sawed wood. The following species of wood may be used: cottonwood, yellow poplar, aspen (popple), spruce, basswood, magnolia, white pine, and white fir.

A regular (domestic) 30-dozen *sawed-wood egg case* is a case made entirely of sawed wood, such as white ash, tupelo, and hemlock.

Dimensions. Dimensions of the standard 30-dozen case must meet the following specifications.

Wood. The outside dimensions of the standard wood case are: $13\frac{3}{8}$ inches high, $12\frac{1}{8}$ inches wide, and $25\frac{7}{8}$ inches long. These cases are constructed of thin material. The sides, top, and bottom are $\frac{3}{16}$ inch thick; the partition and the ends, $\frac{7}{16}$ inch thick, with a cleat $\frac{7}{16}$ inch by about $1\frac{1}{8}$ inches nailed to the ends on the outside.

Fiber. The inside dimensions of *each* compartment in a 30-dozen case, or the one in a 15-dozen case, are: length, $11\frac{3}{4}$ inches; width, $11\frac{3}{4}$ inches; depth, 13 inches.

Wirebound. Length, $23\frac{1}{2}$ inches; width, $11\frac{3}{4}$ inches; depth, 13 inches.

Size of fillers and flats. Fillers and flats for standard 30-dozen cases have the following dimensions.

Fillers. (For use with 13-inch cases.) Minimum outside dimensions, $11\frac{1}{2} \times 11\frac{1}{2} \times 2\frac{5}{16}$ inches. Each cell, center to center: length, $12\frac{5}{32}$ inches; width, $12\frac{5}{32}$ inches; height, $2\frac{5}{16}$ inches.

Flats. Outside dimensions, minimum, $11\frac{7}{16}$ inches square; maximum, $11\frac{11}{16}$ inches square.

Secondhand cases. Secondhand cases can be used to advantage if in good condition. New fillers and flats should be kept on hand to replace broken ones.

How to use the filler. Examination of a filler will show each individual strip to be slit halfway across. Each egg space, therefore, is bounded on opposite sides by a strip of filler which has been slit on either side, thus making this section weak in half of its width. The other two sides have the strong uncut half at the top and are therefore better able to hold the eggs firmly. Fillers should be placed in the crate with the uncut half at the top and crosswise of the case, as most strain and greatest breakage occur through the end movement.

How to remove a filler containing eggs. Many market men like to remove a layer or two of eggs to examine the pack below. In so doing, the hand is pushed down at opposite corners of the filler and slightly toward the front from the corner, between the filler and the case, grasping the filler and flat. The filler, held firmly and bent slightly, is lifted, together with the three dozen eggs it contains. After a little practice, a person may become quite skillful and may transfer an entire case in a short time.

2. U. S. standards for quality of individual shell eggs

Quality standards describe the condition of individual eggs; grades describe the combinations of quality in any given lot of eggs. The quality standard of eggs must be determined before they can be graded.

The quality of an egg changes gradually as it proceeds from the finest, when first laid, toward an inedible condition. The U. S. standards divide these quality changes into four main interior quality conditions, AA, A, B, C; and three exterior quality conditions, dirty, check, and leaker. Any edible egg meets one or another of these standards for quality.

Grades tell the minimum number of these various eggs which comprise a dozen, case, or car. Included in the grade is the *tolerance*, which is the number of eggs of varying qualities permitted in any lot of a single grade.

SPECIFICATIONS FOR OFFICIAL UNITED STATES STANDARDS
FOR QUALITY OF INDIVIDUAL SHELL EGGS

Effective March 1, 1955

U. S. standards for quality of individual eggs with clean unbroken shells

AA Quality. The shell must be clean, unbroken and practically normal. The air cell must not exceed $\frac{1}{8}$ inch in depth and be practically regular. The white must be clear and firm so that the yolk appears well centered and its outline only slightly defined when the egg is twirled before the candling light. The yolk must be free from apparent defects.

A Quality. The shell must be clean, unbroken, and practically normal. The air cell must not exceed $\frac{3}{8}$ inch in depth and must be practically regular. The white must be clear and at least reasonably firm so that the yolk appears at least fairly well centered and its outline only fairly well defined when the egg is twirled before the candling light. The yolk must be practically free from apparent defects.

B Quality. The shell must be unbroken and may be slightly abnormal and may show slight stains but no adhering dirt, provided that they do not appreciably detract from the appearance of the egg. When the stain is localized, approximately $\frac{1}{2}$ of the shell surface may be slightly stained, and when the slightly stained areas are scattered, approximately $\frac{1}{16}$ of the shell surface may be slightly stained. The air cell must not exceed $\frac{1}{2}$ inch in depth, may show unlimited movement, and may be free but not bubbly. The white must be clear and may be slightly weak so that the yolk may appear slightly off center, with its outline well defined when the egg is twirled before the candling light. The yolk may appear slightly enlarged or slightly flattened and may show other definite, but not serious, defects.

C Quality. The shell must be unbroken and may be abnormal and may have slight to moderate stained areas covering not more than $\frac{1}{4}$ of the shell surface, but no adhering dirt. Prominent stains are not permitted. The air cell may be over $\frac{3}{8}$ inch depth and be free or bubbly. The white may be weak or watery so that the yolk may appear off center and its outline plainly visible when the egg is twirled before the candling light. The yolk may appear dark, enlarged, and flattened, and may show clearly visible germ development but no blood due to such development. It may show other serious defects that do not render the egg inedible.

U. S. standards for quality of individual eggs with dirty, checked, or cracked shells

Dirty. The shell must be unbroken and it has adhering dirt or prominent stains, or slight to moderate stains covering more than $\frac{1}{4}$ of the shell surface.

Check. An individual egg that has a broken shell or crack in the shell but with its shell membranes intact and its contents do not leak.

Leaker. An individual egg that has a crack or break in the shell and shell membranes to the extent that the egg contents are exuding or free to exude through the shell. An egg which has a portion of the shell missing



AA QUALITY

Note full container and even, uncrowded position of the 12 yolks held in place by the firm white or albumen surrounding each yolk.



A QUALITY

The white slightly losing its hold on the yolks.



B QUALITY

The white unable to hold the yolks, which (consisting of fat) tend to float.



C QUALITY

The white unable to hold the yolks.

(in excess of an area $\frac{1}{4}$ inch square) is considered a leaker even though the shell membrane is intact.

EXPLANATION OF TERMS ✓

The Official United States Standards for Quality of Individual Shell Eggs are applicable to eggs that are the product of the domesticated chicken hen and are in the shell.

Terms descriptive of shell

Clean. A shell that is free from foreign material and from stains or discolorations that are readily visible. An egg may be considered clean if it has only very small specks or stains, if such specks or stains are not of sufficient number or intensity to detract from the generally clean appearance of the egg. Eggs that show traces of processing oil on the shell are considered clean unless otherwise soiled.

Dirty. A shell which has dirt adhering to its surface or which has prominent stains or slight to moderate stains covering more than $\frac{1}{4}$ of the shell surface.

Checked or cracked. An individual egg that has a broken shell or crack in the shell but with its shell membranes intact and its contents do not leak.

Leaker. An individual egg that has a crack or break in the shell and shell membranes to the extent that the egg contents are exuding or free to exude through the shell. An egg which has a portion of the shell missing (in excess of an area $\frac{1}{4}$ inch square) is considered a leaker even though the shell membrane is intact.

Practically normal (AA) (A). A shell that approximates the usual shape and that is of good even texture and strength and free from rough areas or thin spots. Slight ridges and rough areas that do not materially affect the shape, texture, and strength of the shell are permitted.

Slightly abnormal (B). A shell that may be somewhat unusual in shape or that may be slightly faulty in texture or strength. It may show definite ridges but no pronounced thin spots or rough areas.

Abnormal (C). A shell that may be decidedly misshapen or faulty in texture or strength or that may show pronounced ridges, thin spots, or rough areas.

Terms descriptive of the air cell

Depth of air cell (air space between shell membranes, normally in the large end of the egg). The depth of the air cell is the distance from its top to its bottom when the egg is held air cell upward.

Practically regular (AA) (A). An air cell that maintains a practically fixed position in the egg and shows a fairly even outline, with no more than $\frac{3}{8}$ inch movement in any direction as the egg is rotated.

Free air cell (B) (C). An air cell that moves freely toward the uppermost point in the egg as the egg is rotated slowly.

Bubbly air cell (C). A ruptured air cell resulting in one or more small separate air bubbles, usually floating beneath the main air cell.



AA QUALITY

Note full container and even, uncrowded position of the 12 yolks held in place by the firm white or albumen surrounding each yolk.



A QUALITY

The white slightly losing its hold on the yolks.



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Leaker. An individual egg that has a crack or break in the shell and shell membranes to the extent that the egg contents are exuding or free to exude through the shell. An egg which has a portion of the shell missing (in excess of an area $\frac{1}{4}$ inch square) is considered a leaker even though the shell membrane is intact.

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Bubbly air cell (C). A ruptured air cell resulting in one or more small separate air bubbles, usually floating beneath the main air cell.

Terms descriptive of the white

Clear (AA) (A) (B). A white that is free from discoloration or from any foreign bodies floating in it. (Prominent chalazas should not be confused with foreign bodies such as spots or blood clots.)

Firm (AA). A white that is sufficiently thick or viscous to permit but limited movement of the yolk from the center of the egg, thus preventing the yolk outline from being more than slightly defined or indistinctly indicated when the egg is twirled.

Reasonably firm (A). A white that is somewhat less thick or viscous than a firm white. A reasonably firm white permits the yolk to move somewhat more freely from its normal position in the center of the egg and approach the shell more closely. This would result in a fairly well defined yolk outline when the egg is twirled.

Slightly weak (B). A white that is lacking in thickness or viscosity to an extent that permits the yolk to move quite freely from its normal position in the center of the egg. A slightly weak white will cause the yolk outline to appear well defined when the egg is twirled.

Weak and watery (C). A white that is thin and generally lacking in viscosity. A weak and watery white permits the yolk to move freely from the center of the egg and to approach the shell closely, thus causing the yolk outline to appear plainly visible and dark when the egg is twirled.

Blood clots and spots (not due to germ development). Blood clots or spots on the surface of the yolk or floating in the white. These blood clots may have lost their characteristic red color and appear as small spots or foreign material commonly referred to as meat spots. If they are small (aggregating not over $\frac{1}{8}$ inch in diameter) the egg may be classed as C quality. If larger and/or showing diffusion of blood in the white surrounding them, the egg shall be classified as loss.

Bloody white (loss). An egg, the white of which has blood diffused through it. Such a condition may be present in new-laid eggs. Eggs with bloody whites are classed as loss.

Terms descriptive of yolk

Well centered (AA). A yolk that occupies the center of the egg and moves only slightly from that position as the egg is twirled.

Fairly well centered (A). A yolk that is not more than one-fourth of the distance from its normal central position toward the ends of the egg and swings not more than one-half of the distance from its normal position towards the sides of the egg as it is twirled.

Off center (B) (C). A yolk which is distinctly above or below center and swings close to the sides of the egg as it is twirled.

Outline slightly defined (AA). A yolk outline that is indistinctly indicated and appears to blend into the surrounding white as the egg is twirled.

Outline fairly well defined (A). A yolk outline that is discernible but not clearly outlined as the egg is twirled.

Outline well defined (B). A yolk outline that is quite definite and distinct as the egg is twirled.

Outline plainly visible (C). A yolk outline that is clearly visible as a dark shadow when the egg is twirled.

Slightly enlarged and slightly flattened (B). A yolk in which the yolk membranes and tissues have weakened somewhat, causing it to appear slightly enlarged and slightly flattened.

Enlarged and flattened (C). A yolk in which the yolk membranes and tissues have weakened and moisture has been absorbed from the white to such an extent that it appears definitely enlarged and flat.

Free from defects (AA). A yolk that shows no spots or areas on its surface indicating the presence of germ development or other defects.

Practically free from defects (A). A yolk that shows no germ development but may show other very slight defects on its surface.

Definite but not serious defects (B). A yolk that may show definite spots or areas on its surface but with only slight indication of germ development or other pronounced or serious defects.

Other serious defects (C). A yolk that shows well developed spots or areas and other serious defects, such as olive yolks, which do not render the egg inedible.

Clearly visible germ development (C). A development of the germ spot on the yolk of a fertile egg that has progressed to a point where it is plainly visible as a definite circular area or spot with no blood in evidence.

Blood due to germ development (inedible). Blood caused by development of the germ in a fertile egg to the point where it is visible as definite lines or blood ring. Such eggs are classified as inedible.

General terms

Loss. An egg that is inedible, smashed, or broken so that contents are leaking, cooked, frozen, contaminated, or containing bloody whites, large blood spots, large unsightly meat spots, or other foreign material.

Inedible eggs. Eggs of the following description are classed as inedible: black rots, white rots, mixed rots (addled eggs), sour eggs, eggs with green whites, eggs with stuck yolks, moldy eggs, musty eggs, eggs showing blood rings, eggs containing embryo chicks (at or beyond the blood ring stage), and any eggs that are adulterated as such term is defined pursuant to the Federal Food, Drug, and Cosmetic Act.

3. U. S. consumer grades of eggs

After individual eggs have been separated into their various qualities, as AA, A, B, C, they may be assembled into grades.

The distinction between standards for quality and grades is most often misunderstood. The standards for quality . . . refer to the classification of the *individual egg*. Each egg in a lot is classified as AA quality, or B quality, etc., not as Grade AA, Grade B, etc.

But eggs are commonly sold, traded, and handled in dozen and case (30-dozen) lots. If all the eggs in a dozen or case were alike (of the same quality) and stayed that way, the *grade* of the lot would be the same as the quality. However, they are not all alike and do not change exactly

the same way. There are borderline classifications, and judgments of operators vary. Hence, the *grades* are established to take care of these variations.

It is assumed that in packing a lot of eggs in a candling room, only one quality of eggs will be placed in the lot. Hence, the operator should pack only *A quality* eggs in a *Grade A* carton. To allow for the human element of variation as well as the natural element of variation in the keeping quality of the eggs and the differences in candling lights, the grades have been set up with a tolerance. This tolerance is, generally speaking, 20 per cent of the next lower quality standard. Also, in classifying eggs which have not been candled previously, various mixtures are found. The tolerances in *wholesale* grades are set up to take care of this factor to a small degree.

There are four consumer grades for eggs with clean shells; namely, Grade AA, Grade A, Grade B, and Grade C, which correspond to the four qualities identified by these letters.*

SUMMARY OF SPECIFICATIONS FOR U. S. CONSUMER GRADES FOR SHELL EGGS

(1) U. S. Consumer Grade	(2) At Least 80 Per Cent (Lot Average) ¹ Must Be:	(3) Per Cent	(4) Tolerance Permitted ² Quality
U. S. Grade AA	AA quality	15 to 20 Not over 5 ³	A B, C, or check
U. S. Grade A	A quality or better	15 to 20 Not over 5 ³	B C or check
U. S. Grade B	B quality or better	10 to 20 Not over 10 ³	C Dirty or check
U. S. Grade G	G quality or better	Not over 20	Dirty or check

¹ In lots of more than 30 cases, no individual case may fall below 70 per cent of the specified quality, and no individual case may contain more than double the tolerance specified for the respective grade.

² Within tolerance permitted, an allowance will be made at receiving points or shipping destination for $\frac{1}{2}$ per cent leakers in Grades AA, A, and B, and 1 per cent in Grade G.

³ Substitution of higher qualities for the lower qualities specified is permitted.

Determining the grade of one dozen eggs. The preceding grade specifications apply to 1 dozen or any number of consumer-grade eggs. To illustrate, we will apply the table to 1 dozen eggs of each grade and determine what may be included in each. In 1 dozen

* From *Egg Grading Manual*, Agr. Handbook 75, USDA Agricultural Marketing Service, Washington, D. C., October 1955.

Grade AA eggs, there must be at least 10 eggs of AA quality. From column (2): 80 per cent of 12 eggs equals 9.6. To have 9.6 eggs, there must be 10. The entire 12 eggs may, of course, be AA quality, but a minimum of 10 is required. What quality can the other 2 eggs be? From columns (3) and (4): not over 5 per cent may be B, C, or check. This is 0.6 of an egg. Since eggs cannot be divided, this means we cannot have even 1 egg of those qualities in 1 dozen Grade AA. But 15 to 20 per cent may be of the next lower quality than AA or A (20 per cent of 12 = 2.4, or 2 eggs permitted).

Therefore, a dozen of Grade AA eggs may contain 10, 11, or 12 AA quality eggs, and 2, 1, or 0 eggs of A quality, respectively.

In the same way, using the respective figures, 1 dozen Grade A eggs will have 10, 11, or 12 AA or A quality eggs in any combination, and 2, 1, or 0 eggs, of B quality, respectively.

A dozen Grade B eggs may have as tolerance 10 per cent, or 1 egg either dirty or check and 1 egg of C quality; or the dozen may contain 2 C's and no dirty or check eggs.

A dozen Grade C eggs may have as tolerance 2 dirty or 2 check eggs, or 1 of each.

Remember *tolerances* in determining grades.

Grade	Tolerance
AA and A	2 of the next lower quality
B	2 C's, or 1 C and 1 dirty or check
C	2 dirties or 2 checks, or 1 of each

Examples	Grade of the Dozen
12 A	A
10 A, 2 B	A
4 AA, 2 A, 4 B, 2 checks	C
11 A, 1 D	B
11 A, 2 D	C

4. Factors affecting the interior quality of eggs

The quality of an egg is influenced by a number of factors, some of which are discussed below.

Temperature. The older or more inferior an egg is, the more rapidly will it be affected by high or low temperature. An egg which has been in storage for several weeks or months will, upon being removed from storage, deteriorate faster than a new-laid egg of the same candling quality.

The eggs should be cooled immediately after they are laid. Temperatures above 60 degrees will cause some deterioration in the quality of the egg whether fertile or infertile, but this is particularly true of fertile eggs. Warm, dry air causes rapid evaporation, especially if it blows over the eggs. Weak, watery eggs of a stale flavor soon result.

Sharp and Powell, of Cornell, found the temperature and the number of days required to lower the quality of eggs to the same point (about B quality), as follows:

Number of Days	Temperature, degrees F.
3	98.6
8	77.0
23	60.8
65	44.6
100	37.6

The importance of low temperature is evident. Temperature is of greater importance than age.

High temperatures permit the mucin fibers in the albumen to break down and liquefy, and water to pass from the albumen to the yolk, thus increasing its weight, stretching and weakening the vitelline membrane, and causing the yolk to flatten. A beneficial gas, carbon dioxide (CO_2), is lost from the egg.

Quick cooling drives the heat out quickly and retards the loss of CO_2 , thus helping to maintain quality.

The dark-yolk problem. The dark yolk, as it is called where eggs are candled for the eastern market, is largely a fallacy based on a combination of conditions which have tended to outweigh the facts. Consumers, in general, prefer the yolk color *uniform* when breaking out several eggs. Whether the color is light, medium, or dark is less important, but extremely light or dark yolks are less popular with the consumer.

Weak whites may be hereditary or may result from breaking down under high temperature. Green feed causes dark yolks, as also does heavy yellow-corn feeding. Both conditions are found in many eggs produced on general farms. Eggs of low quality or with weak whites have a more distinct yolk shadow because, when candled, the yolk comes closer to the shell, shuts out more light, and therefore casts more shadow. When a low-quality egg which shows considerable yolk shadow is broken out, the yolk may be either light or dark in actual color.

An egg with firm albumen has a yolk shadow only slightly defined and is considered by many to have a light yolk, although upon breaking it may be found dark. What the person candling sees is the yolk shadow, not the color of the yolk.

A dealer rather than a consumer prejudice against the supposedly dark yolk has thus been built up.

Yolk centering. As the white of the egg becomes thinner, its hold on the yolk becomes less. Being lighter in weight than the white, the yolk leaves the exact center of the egg and rises. Hence, the expressions "well centered," indicating finest quality, and "fairly well centered" or "off center," for eggs of less desirable quality.

Fertile eggs. Before the egg is laid, the embryo in the fertile egg has been developing for several hours. If the animal heat is not removed at once, this development soon continues to such an extent that the embryo can be seen by candling. The temperature in the nest on a hot day may be 100 degrees F., perhaps more.

When hens are laying heavily or if broody hens are not confined regularly, the eggs may be at incubation temperature for several hours after being laid. Quality has started down, but the person candling often cannot detect it then. However, if the egg is held in a warm place and slow growth of the embryo continues until blood forms, the embryo may die when the egg is cooled, causing the formation of a blood ring. This ring may be very small and is sometimes difficult to see before the candle, or it may be of considerable size.

A fertile egg kept at a temperature of 68 degrees F. for several days will develop slightly. When the embryo dies, decomposition sets in, and in time the egg rots.

Males have no influence on the number of eggs a hen may lay. They are necessary *only* when fertilized eggs for incubation purposes are desired. Males should not be present in a flock which produces eggs for market only. It is particularly important that the males be removed from the laying flock during the warm weather months of late spring and summer.

Infertile eggs. An infertile egg will not rot if the shell is kept dry, but the quality will quickly deteriorate at temperatures above 60 degrees F., or in dry air.

Freezing. Freezing must be guarded against, as it breaks down the white and may crack the shell, preventing the egg from being first quality. Eggs freeze at about 28 degrees F.

Moisture. Relative humidity of 75 per cent or higher in the air surrounding eggs is desirable. Low humidity in the egg-holding room causes moisture to be drawn from the egg. Some moisture is drawn completely through the shell, resulting in an enlarged air cell, while some is stopped where it spreads between the layers of shell. A pronounced mottled appearance of the shell is often apparently traceable to low humidity in the room where eggs are held, although exact knowledge of its cause is not known. *Mottling* is not considered a quality factor. When it becomes pronounced, however, it does detract from the general external appearance of the eggs.

Absorption of odors and flavors. The egg readily absorbs odors, which may or may not be lost in cooking. Care should be taken to keep the eggs away from filth, disinfectants, decaying vegetables, or any other substances possessing a disagreeable odor.

5. Why eggs lose quality

The subject of egg quality is one of great interest and is open to considerable controversy. It is generally assumed that the eggs are best when first laid. Certainly, the individual egg will never be any better or fresher, if we may use that term, than immediately after it is laid.

It is well to keep in mind that eggs when first laid are not always of high quality. In fact, it is not impossible (though it rarely occurs) for hens to lay eggs which are inedible. Eggs may show all degrees of quality, from the very finest to the inedible, immediately after they have been dropped by the hen. The causes of this are several.

Eggs from different hens may vary in quality. One hen may consistently lay A quality and another B quality eggs. Occasionally, though rarely, the quality of a hen's eggs may vary because of low vitality, either naturally or as a result of feeding or management or some abnormal condition. Through fear or undue excitement, hens sometimes hold their eggs within their bodies for a considerable length of time. Certain diseases affect both exterior and interior quality of eggs. Infectious bronchitis and Newcastle disease are two such diseases. (See pages 266 and 279.)

Because of bacterial infection from the body of the hen, or because the germ in a fertile egg dies, or for other reasons, decomposition may set in. The natural high temperature of a hen's

body, 105 to 107 degrees F., hastens the breaking down of the egg if held for long within the body.

An egg may mature and reach a point where it is ready to be

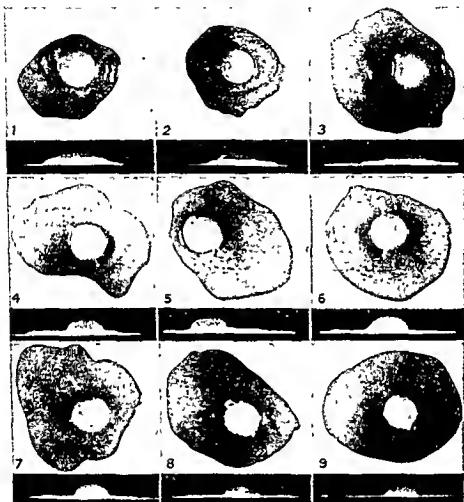


FIG. 107. Albumen condition of eggs. Individual hens differ in the albumen condition of their eggs. Each egg was broken out the day it was laid. Note the typical uniform yolk condition found in such eggs. Note also the great variation in albumen condition from very firm white in 1 to complete thin white in 9. The height of firm albumen may best be seen in the side view just beneath each top view. Photograph from Van Wagenen and Wilgus.

laid just after a bird has gone to roost in the evening, and may be held until the following morning in the body of the bird. Twelve or 14 hours at that high temperature after the egg is ready to be laid might lower the quality before the hen lays the egg the following day.

Hence, it cannot be said that eggs are of exceptionally high

quality in every instance because they were just laid or because they reached the market a very short time after being produced; an egg may be well along on its quality journey by the time it is laid (Fig. 91). Under normal conditions, however, the majority of eggs just laid are of fine quality.

Eggs are perishable. Regardless of the quality when laid, an egg moves rapidly from its original quality toward a still lower quality unless something is done to check it. The rapidity of this movement toward lower quality depends on the environment surrounding the egg.

Because there is no known method for making an egg better in quality once it is laid, and because eggs always move toward lower quality, it follows that our only chance of getting to market eggs as good in quality as when they were produced is to provide conditions which will hold the original quality that the hen put into the egg.

6. Home preservation of eggs

In some homes, it is desirable to preserve eggs during the spring of the year when eggs are plentiful and prices are low. For long holding, low temperatures (not below 32 degrees F.) are recommended, regardless of how the eggs may have been treated. Eggs properly preserved may be held for several months in a cool cellar and used during the following fall and winter.

Water-glass treatment. Of the many ways of preserving eggs at home, the water-glass solution is the most popular.

Preparing water glass. Materials needed for 30 dozen eggs:

18 quarts water

1½ quarts water glass (commercial)

2 eight-gallon earthen or metal containers

Work by Dr. G. O. Hall at Cornell showed that ordinary clean water is as satisfactory as boiled water previously recommended. Also, metal containers are as desirable as earthen containers.

Clean the containers with soap and warm water, and rinse. Pour the water into the crocks and add the water glass. Mix the water and water glass thoroughly with a clean stick or long-handled spoon.

Candle or tap the eggs together gently in order to detect any cracked eggs. Only fresh, sound, uncracked eggs should be placed in water glass. Lower the eggs into the solution, several at a time, with a long-handled dipper or spoon.

The crocks may be filled at once or the eggs added daily as gathered.

Five quarts of additional water to each $1\frac{1}{2}$ quarts of water glass may be added if needed to cover the eggs, which should always be kept submerged. Place a cover on the container.

Eggs may be removed as needed. Water-glass eggs should be punctured with a pin in the large end for boiling, to prevent the shell from bursting.

Community Survey

1. What percentage of the poultrymen whom you know have special rooms for holding market eggs until shipped?

2. Inquire of one or two of them what features they have found desirable in their egg rooms.

3. How are their eggs sorted for size?

4. What benefit does this bring to the poultryman?

5. Name the sizes used by the poultrymen.

6. What percentage of the eggs need cleaning? How are eggs cleaned?

7. Do these men candle their eggs? Why or why not?

8. At what season of the year are eggs candled?

9. How many poultrymen visit the markets occasionally to confer with the market men?

10. List the handling methods and the care given the eggs from the time eggs are laid until shipped from the farm. How can these practices be improved?

11. In one day's collection, how many eggs weighed 2 ounces or over? How many were chalk-white? Checked? Dirty? Poorly shaped?

12. How are eggs cleaned?

13. Describe how eggs are packed for shipment.

14. Do the poultrymen in your community use new or secondhand cases and fillers? Compare dimensions with those in this chapter.

15. Where do they buy cases, and in what quantity?

16. What is the difference in price between new and secondhand cases?

17. What is the rate on a crate of eggs from your farm to the market? What percentage is shipped by train? By truck? To whom are the eggs sold?

18. What prices are being received by several of the poultrymen in the community?

19. What reasons can you give for the differences received?

20. What are the estimated costs and time required for preparing eggs for market?

21. Write to your state department of agriculture for information on state grades, laws, and regulations governing eggs. Study these to see wherein they are similar or differ from those put out by the USDA.

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Preparing Poultry Meat for Market *

From the general farms in the United States a vast amount of poultry is available for human food, and it is estimated that about one-fourth is used at home and three-fourths sent to market. Where and how this poultry is sold will depend on the location of the farm, the amount to be sold from the farm and in the same vicinity, the availability of consumers (whether nearby or distant), whether the poultry is a by-product or is grown especially for meat, the facilities at the farm for processing or for transportation, the price, and the inclination of the producer.

Operations:

1. Deciding how to sell.
2. Preparing for killing.
3. Methods of killing.
4. Methods of picking.
5. Cleaning and cooling the carcass.
6. Drawing fowls or roasters.
7. Trussing.
8. Cutting fowls.
9. *Preparing broilers.*
10. Deboning.
11. Home canning poultry.
12. Preparing poultry for the freezer.
13. Caponizing.
14. Hormonizing.

General information:

Standards for quality.

* For a more complete discussion of this subject, the reader is referred to *Marketing Poultry Products*, 4th ed., by Benjamin, Pierce, and Termohlen, published by John Wiley & Sons, New York, 1949.

Operations

1. Deciding how to sell

Selling alive. Poultry is marketed for meat in one of the following ways:

(a) Direct to the consumer at the farm or public market, or delivered to the consumer's home.

(b) To the consumer through freezer locker service. Here poultry is delivered by the poultryman to the locker plant, which prepares it for freezing and places it in the customer's locker or delivers it to the customer at the locker plant.



FIG. 108. Shipment of 200 fowl about to leave the farm.

(c) To a dealer or local buyer. The dealer furnishes the crates and pays according to the weight at the farm. Returns per pound alive at the farm are several cents less than prices quoted in the market. The difference covers shrinkage and transportation charges, and nets about the same to the poultryman.

In the intensified broiler or fryer growing sections of the United States, and frequently elsewhere, processing plants have been built to which live birds are sold on delivery by the producer or when picked up by plant trucks. From these areas also live poultry is trucked wherever there is a demand for the product.

(d) Through a cooperative association auction, which may provide the necessary crates and return a price to the producer based on the auction sale minus the commission and handling charge.

(e) To a wholesale commission merchant, generally located in cities or near poultry markets, who represents the shipper and returns payment to the shipper based on the sale of the birds. The shipper is likely to be someone who has purchased the poultry from the producer, as such selling involves large shipments. *Small express shipments are a thing of the past.*

Farms located far from market are likely to sell their birds alive through local buyers, who sell to poultry packers. The packer may or may not fatten the birds, but eventually they are dressed

(bled and feathers removed), perhaps eviscerated, packed, usually frozen, and shipped to market. Large outlets for dressed poultry are concerns which make canned soups or canned chicken. Formerly, most of this poultry was shipped alive in railroad cars especially built for the purpose. *Today there are practically no rail shipments.* Shipments by *truck* have increased tremendously.

For poultrymen located near large markets, the live-poultry market is particularly attractive if shipment can be made just before the Jewish holidays. (Ask your dealer for a list of these

Table 13. Summary of Standards for Quality of Live Poultry on an Individual Bird Basis ¹

(Minimum Requirements and Maximum Defects Permitted)

Factor	A or No. 1 Quality	B or No. 2 Quality	C or No. 3 Quality
Health and vigor	Alert, bright eyes, healthy, vigorous	Good health and vigor	Lacking in vigor
Feathering	Well covered with feathers showing luster or sheen Slight scattering of pinfeathers	Fairly well covered with feathers Moderate number of pinfeathers	Complete lack of plumage feathers on back Large number of pinfeathers
Conformation:	Normal	Practically normal	Abnormal
Breast bones	Slight curve, $\frac{1}{8}$ " dent (chickens), $\frac{1}{4}$ " dent	Slightly crooked	Crooked
Back	Normal (except slight curve)	Moderately crooked	Crooked or hunched back
Legs and wings	Normal	Slightly mishapen	Mishapen
Fleshing	Well fleshed, moderately broad and long breast	Fairly well fleshed	Poorly developed, narrow breast, thin covering of flesh
Fat Covering	Well covered, some fat under skin over entire carcass Chicken fryers, turkey fryers, and young toms only moderate covering No excess abdominal fat	Enough fat on breast and legs to prevent a distinct appearance of flesh through skin Hens or fowl may have excessive abdominal fat	Lacking in fat covering on back and thighs, small amount in feather tracts
Defects:	Slight	Moderate	Serious
Tears, broken bones	Free	Free	Free
Bruises, scratches, calluses	Slight skin bruises, scratches, calluses	Moderate (except only slight flesh bruises)	Unlimited to extent no part unfit for food
Shanks	Slightly scaly	Moderately scaly	Seriously scaly

¹ U. S. Department of Agriculture, Production and Marketing Administration. Standards effective January 1, 1950.

days.) The price is usually 1 or 2 cents higher immediately preceding these dates. The Jewish market takes most of the live poultry.

Using live-poultry shipping crates. One of the most serious problems confronting flock owners selling live birds is this matter of chicken crates. They are an important, if not the most important, factor in the transmission of disease when hucksters, local buyers, and truckers for auctions are permitted to take their crates into pens and houses. Flock owners should have a set of their own crates so that the birds can be transferred to the buyer's crates outside the buildings. Some poultrymen have placed a portable house at the entrance to their premises for the primary purpose of transferring birds from their crates to those of the buyer.

The standard live-poultry shipping crate is 3 feet by 2 feet by 12 inches high. It finds many uses around the plant. The sides are spindles. Twelve to 15 fowls or 15 to 25 broilers, depending on the size, are sufficient for one crate. It does not take the place of the usual farm catching crate which is built so poultry may be driven into it.

Selling dressed. A great change in the markets in recent years has been from live to dressed poultry. Dressed poultry requires most time for preparation. Chilling facilities are necessary unless the poultry is sold at once. Dressed poultry is sold from the farm either direct to the consumer or to the retailer. To both outlets, poultry may be *dressed, ready-to-cook, or cut up.*

The farm dressing plant. In some instances poultrymen find it profitable to develop local trade by installing farm dressing plants at home. Possibilities for the farm dressing plant rest with the demand, type of birds grown, available labor, and time for preparation and delivery. A farm dressing plant fits in well if one has a regular marketing route for other farm produce, or if the location is such that people drive out to the farm for eggs and poultry or other produce, or if the farm operates a roadside stand for transient trade.

It is for those who contemplate preparing poultry for a dressed-poultry trade, or who are actually doing so, that this chapter is prepared. Not only does a discriminating trade enjoy the appearance of poultry which is well fattened and well dressed, often paying a premium for appearance as well as for quality, but there should be a genuine feeling of satisfaction on the part of the person who knows how to do this end of the work well and who can

and does put up a product which is decidedly pleasing in every respect. Such a person is proud of his products and takes pleasure in showing his wares to a prospective customer.

2. Preparing for killing

Although fattening or special feeding may be practiced in large processing plants, it is much less prevalent on poultry farms than formerly. When poultry is properly fed on modern rations, the condition is excellent and special feeding is seldom necessary.

If the poultry is to be sold dressed, keep the birds without food for 4 hours in order to empty the crop completely. If the birds are to be eviscerated, withhold feed for 12 hours to partially empty the intestines. Water may be left before the birds until they are killed.

The killing and dressing quarters. When many birds are to be slaughtered, it is well to provide a place where the work can be done quickly and easily. A special room is available on many plants. There are many possible variations in arrangement. Features needed are:

- A complete unit
- Ample size to do the job easily
- Operations progressively arranged
- Limited amount of carrying
- Crosswalking reduced to a minimum

A room having 200 to 300 square feet of floor space will usually meet requirements on a 1000- to 1500-bird plant. Storage may require the largest space.

The killing equipment. *Figure 109 shows the larger pieces of equipment ordinarily used on plants where a number of birds are dressed or full drawn at one time.* In addition, smaller pieces of equipment needed would be knives, singeing apparatus, string, waste containers, and paper. Important details are provision for disposal of the offal, and ample water conveniently located for cleaning birds and equipment.

For a few birds, the killing and scalding equipment needed would be a holding string or shackle (Fig. 110), a weight for holding the head down or a blood cup, and a boiler or large pail for scalding.

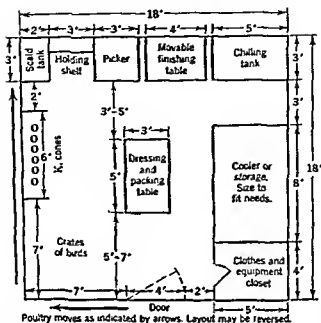


FIG. 109. Killing, dressing, and cooling room. A suggested guide for placing equipment.

3. Methods of killing

Sticking and debraining. When birds are bled, that is, the blood vessels in the throat cut, this procedure is referred to as sticking. Sticking in the mouth gives excellent bleeding when correctly done. Where dry picking is practiced, the brain is pierced immediately afterward, which loosens the feathers. This procedure or operation is known as debraining.

From the inside. Hang the bird up. Grasp the head with the left hand, comb in the palm and palm up. Hold the head with the fleshy part of the thumb and forefinger against the bones near the earlobes (Fig. 111). Do not press against the soft part of the neck, as this stops the flow of blood. With the middle finger of the left hand, open the beak. Insert the knife, being careful *not* to cut the throat, until the point shown in Fig. 112 is reached. Hold the knife at an angle in order to cut both blood vessels. Make a quick single cut, pressing against the neck.

When the bleeding is well started, debrain the bird. Hold the head as before, and place the point of the knife in the groove at the roof of the mouth and exactly between the eyes. Push the knife back on a line almost directly between the ear openings, until the base of the skull is reached. (See Fig. 200 for location of

medulla, cerebrum, and cerebellum.) The point of the knife will strike the brain there and render the bird unconscious. This section of the brain controls the muscles that hold the feathers in place. Give a half turn of the knife to destroy the tissue.



FIG. 110. A simple homemade contrivance for holding the bird while killing. The string is wrapped once around the leg and the block left at right angles to the leg. Do not tie.



FIG. 111. The knife in position for bleeding the bird. Held crosswise, the point of the knife is raised to show its position before pressing down against the neck bone and drawing out to make the cut. In large processing plants the bleeding is done from the outside, cutting through feathers and skin in the same direction and at the same location, making an incision $\frac{1}{2}$ " to $\frac{3}{4}$ " long and hitting the same blood vessels.

When the proper point is hit, the bird gives a characteristic squawk. The feathers are loosened if the stick is correctly made. Successful sticking and debraining require considerable practice.

From the outside. A method of bleeding used by many slaughter-houses and individuals is to grasp the head of the bird as described previously and, with a sharp knife, cut between the left earlobe and jawbone through skin and tissues to the neck bone. Since the blood vessels meet at that point (Fig. 112), the short deep cut severs them and good bleeding occurs.

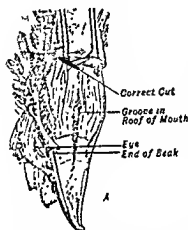


FIG. 112. Location of veins to be cut and the groove in the roof of the mouth through which the knife is inserted when debraining. From Bureau of Chemistry, USDA, Circ. 61.

Debraining may be accomplished by inserting the point of the knife through the soft tissue below the eyeball and pushing the knife back to the base of the skull.

Cutting off the head. This is perhaps the most common method of killing for home use. The legs and wings are grasped with one hand, and the head laid on a block. The neck is severed with a hatchet. To prevent throwing blood, the neck is held with the flat part of the hatchet until all bleeding and struggling ceases. The beginner may make a better cut if the neck is laid between two nails driven into the block, and drawn back until the head is held firmly, thus stretching the neck out. The bleeding caused by cutting off the head is satisfactory, provided a sharp

instrument is used and bleeding is not restricted.

Dislocating the neck. This is a popular method where birds are to be full drawn. It is done by holding the legs in the left hand, near the left hip of the operator (Fig. 114). With the breast of the bird out, grasp the head, having the thumb at the back near the base of the skull, the palm against the face, and the middle finger across the under side of the beak. Bend the head back at nearly a right angle (Fig. 115). Holding the legs firmly, pull down sharply with the right hand.

The neck will separate at the base of the skull and sever the blood vessels there. Stretch the neck to provide space for the blood to accumulate. Bleeding is quite complete, all the blood being held in the neck, as the outside skin is unbroken. If the bird lies awhile before dressing, the blood coagulates and the usual



A



B

FIG. 113. A. The approximate position of the knife when debraining. The cerebellum lies near the point of the knife. B. The knife in place for making the stick.



FIG. 114. Dislocating the neck.



FIG. 115. Dislocating the neck. With the head held in this manner, a straight downward pull separates the head and neck.

method of dressing may be followed. This is an excellent way to kill sick or injured birds. No blood reaches the outside.

4. Methods of picking

Dry-picking. After bleeding and debraining, hook a weight on the beak and start immediately to pick. Dip the fingers in water to make the plucking easier. Hold the wings near the body with one hand and pick with the other until the bird ceases to flop.

Pick the feather tracts on the breast first, as these are most likely to tear. Grasp a handful of feathers and pull the hand over and



FIG. 116. Pinfeathering. The "stubbing knife" helps.

down in a rotary motion. If the feathers stick, let them slip through, being careful not to tear the skin. Follow with the feathers on the thighs and back at base of wing. Next grasp a wing with one hand and all the quills in it with the other, and pull all out at once with a quick downward pull. Repeat on the other wing. Pull out the tail feathers next. Follow with the neck feathers. Any remaining large body feathers are next removed, and finally the pinfeathers. A blunt-bladed knife helps in removing the pinfeathers, which are grasped between the blade and the thumb (Fig. 116).

Scalding and hand-picking. Scalding is done after bleeding and debraining. When scalding is properly done, the appearance is not materially different from that of dry-picked poultry.

Scalding is desirable in the case of birds intended for home consumption, and many markets do not object to it—some even prefer it.

Hot scald. The temperature of the water should be just below boiling (180 to 190 degrees F.). It is important to avoid cooking the skin. Hold by the head and feet and keep these parts out of the water. Draw slowly through the water, *with* the feathers



A



B



C

FIG. 117. A. Killing funnels prevent bruising. B. Killing shackles are used when killing, dry-picking, or when removing pinfeathers, or for general cleaning after scalding. C. After scalding, the bird is held and rolled on the picking machine.

and not against them. Keep the bird moving forward to prevent the water from flowing between the feathers to the skin. This should steam the base of the feathers and not cook the outer skin. It may be necessary to dip more than once. Immediately after scalding, hold by the legs and dip in cold water and out, and proceed at once to remove feathers. This further retards any cooking of the skin.

Semiscald. This method consists of debraining the bird and, before it is completely through flopping, immersing it in water

heated to 126 degrees F. for broilers and 128 degrees F. for fowls and roasters, moving it back and forth in the water for 30 to 45 seconds. This does away with much of the skin injury caused by scalding. The appearance and condition of the carcass are similar to dry-picked poultry.

Machine picking. Bleed, debrain, and semiscald at 126 to 128 degrees F. Place on the picker. Do not press the carcass against the fingers of the machine. Holding the legs apart, permit the bird to bounce and roll from side to side. With one hand on the head, roll the neck on the picker. Holding legs and head, place the abdomen on the machine. Do not try to get all the feathers off by machine, but hand-pick the balance.

It is possible to machine dry-pick properly debrained poultry.

Subscalding at 140 degrees F. before machine picking results in easier picking, but the bloom or outer thin layer of skin is lost. For frozen cut-up poultry or where outer appearance is less important, it is often done. The carcass should be kept moist until wrapped for freezing.

Wax picking. Where a high-quality trade prevails, wax picking is still practiced by certain large processing plants and some smaller operators. A special wax makes this method adaptable to machine picking.

5. Cleaning and cooling the carcass

If the birds are to be sold or held for a period of time without eviscerating (removing the internal organs), wash the feet, clean the blood from the mouth if sticking has been done, and give the head a quick downward thrust to dislodge any clotted blood. The carcass should then be cooled. (In the larger processing plants, birds are usually eviscerated before cooling.)

Table 14. Losses Due to Dressing and Drawing
(Based on Live Weight)

Average Weight, Alive	Loss Due to Dressing, per cent	Loss Due to Drawing, per cent
Under 3 lb.	13	27
3 to 4 lb.	11	25
4 to 5 lb.	10	22
Over 5 lb.	9	18

The animal heat should be quickly removed after plucking. The carcasses may be hung on racks and cooled in a temperature of 35 degrees F. A clean cool cellar is very satisfactory. Moving air results in better looking carcasses.

The birds may be placed in clean cold water, iced, and left there from 1 to 2 hours. Water cooling lessens the keeping quality if the birds are to be stored, but is used more often than air cooling in large plants.

6. Drawing fowls or roasters

Until recently, poultry to be shipped was not drawn. At present the tendency is to draw poultry for shipment if it can be immediately frozen and held in that manner. Much of it is wrapped or packaged and labeled "ready to cook."



FIG. 118. Poultry killing and dressing implements: *a*, chicken killing knife; *b*, turkey killing knife; *c*, deboning or dressing knife; *d*, heavy cutting knife; *e*, dressing knife; *f*, pinner; *g*, shears; *h*, sharpening stone.

For home use or the retail trade, the following description of drawing the bird, with accompanying illustrations, may be used as a guide.

Singe the bird over a low alcohol or gas flame, burning off the hair but not scorching the flesh. Denatured alcohol does not produce smoke to discolor the skin.

(a) Bird on breast, head toward you. Cut through skin from point between shoulders along back of neck to head. Separate skin from neck bone. Cut through flesh at both ends of neck, twist or cut with shears and remove.

(b) Separate windpipe and gullet from skin. Reach forefinger into the body through front opening, loop under and around the

gullet between crop and gizzard and pull out, removing the crop. Cut off head. Insert forefinger and loosen lungs and heart.

(c) Reverse the position of the bird, with the feet toward you. Cut through skin on rear of shank. Insert forefinger under a tendon and pull out, or insert clothespin or stick under a tendon. Place the bird's foot flat against your body. Grasp stick on both sides of tendon and pull out. Repeat for each tendon. Tendons can be

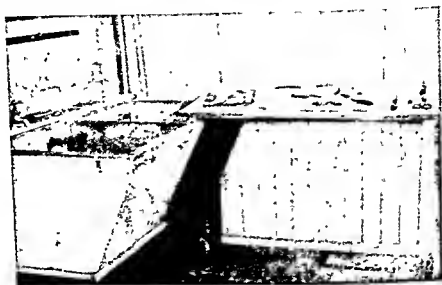


FIG. 119. Shelf for dressing and tubs for washing poultry. The shelf is on hinges and folds upward against the partition.

removed much easier and in less time by using a regular tendon puller, which can be purchased from supply houses handling poultry marketing equipment. With a tendon puller, all tendons in both legs are removed in one operation.

(d) Place the bird on its back, tail toward your right. Cut between the vent and tail. Insert forefinger of left hand, loop up over the intestine and out the other side. Cut around the vent. If more room is needed, cut toward the right leg from just above the pubic bone.

(e) Remove intestines, gizzard, lungs, liver, and heart. To remove kidneys work them loose from the back with the forefinger.

(f) To facilitate carving, the wishbone may be removed. Set the bird on its rump, back toward you, fold the neck skin down over the breast and scrape the upper surfaces of the wishbone. Insert knife under the bone and work loose at upper end. Repeat



a



b

FIG. 120. Drawing the bird. Steps a and b.



Fig. 121. Drawing the bird Step c.

on other side. With point of knife and thumb work flesh away from the lower part of the wishbone and remove.

(g) Remove the oil sac.

(h) Trim heart, liver, and gizzard.



d



e



f



f

FIG. 122. Drawing the bird. Steps *d*, *e*, and *f*.

(i) Wash inside of carcass and wipe exterior with clean cloth.

(j) Singe, if necessary.

(k) Place heart, liver, gizzard, and neck in body cavity.

7. Trussing

The purpose of trussing roasting birds is to make the carcass compact and attractive. There are several methods. The following description is for the butcher's truss.

(a) Place the bird on its breast, tail toward you. Fold neck skin over the back. Bend each wing tip under and up onto the back to hold the neck skin.

(b) Place the bird on its back, tail toward you. Work a loop of string down over the front, back between the wings and body.

(c) Pulling firmly, cross the string under the back and carry it up and over the drumstick near the outer joint. Pull down tight.

(d) Turn the bird over and tie the string across the tail.



a



b



c



d

FIG. 123. Trussing for roasting. Steps a, b, c, and d.

Sometimes the string slips off the tail. The following method of trussing solves that difficulty and is often preferred, especially when poultry is to be frozen.

Place the bird on its breast, tail away from you. Tie the center of the string around the tail, carry the string up and over the drumsticks near the outer joint. Pull firmly, cross the string under the back and up between the body and wing, and tie (See Fig. 124.)

8. Cutting fowls

Certain retail stores and producers catering to private trade sell light and dark meat, parts for soup (backs, necks, and wings), and giblets. Others cut fowl into more parts for stewing or fricassee.

One method is described here.

(a) Remove shanks; cut around vent.

(b) Cut skin between body and thigh; bend thigh and leg back, dislocating thigh joint. Remove, and repeat on the other side.



A



B



C



D

FIG. 124. Trussing, alternate method for roasting or freezing. A. Bird on back, tail away from operator. Tie string around tail and cross over drumsticks, pulling tight. B. Cross string under back, pass between body and wings, let string slide under the carcass, pull tight and tie. C. Wings may be folded with tips over the back, or tied close to the body if the carcass is to be wrapped for freezing. D. Carcass ready for wrapping.

(c) Bird on its side. Cut with knife or shears from pubic bone, straight to wing joint. Sever bone just below wing joint. Repeat on other side.

(d) Bird on its back. Lift breast with left hand, tear attachments from beneath with right hand. Remove breast.

*b**c*

FIG 125 Cutting fowls Steps *b* and *c*.

(e) Bird on its side. Start at rear and separate intestines, oviduct, crop, and all organs from back, and esophagus and windpipe from the neck. Cut off head. The neck and back may be left in one piece. Remove oil sac.

(f) Clean liver, heart, gizzard.

For *stewing* or *fricasee*, the carcass may be cut up further if desired.

(g) Separate drumstick and thigh by cutting at the joint between them.

(h) Remove neck bone close to the shoulder.

(i) Bend front part of back at joint and remove.

(j) Cut the wishbone free, cutting across near the front end of the keel or breastbone or sternum (Fig. 206) down to solid bone, and then turning the knife to cut diagonally until free, leaving considerable white meat attached.

(k) Cut through skin and flesh down both sides of the breastbone. With the thumb, work breast meat away from the rest of bone. Cut the piece in half. Repeat on other side.

The abdominal fat is usually detached and delivered as a separate piece.

Back, thighs, and wings may be halved if the carcass is large.

9. Preparing broilers

Halving and quartering a broiler. The object is to cut the carcass to lie flat while cooking and to serve in halves or quarters, depending upon size of portion. This is done for use at home or for retail sale. The method is as follows.

(a) Remove the shanks; cut around the vent and let it hang free.

(b) Remove the oil sac.

(c) With shears or knife, start near the tail and cut through the bones alongside of the backbone to the neck.

(d) Repeat on the other side of the backbone, slitting the skin on the neck to the head.

(e) Remove the backbone and neck in one piece, severing at the head.

(f) Place the bird on its breast. With knife, locate the base of the V at the breast in front, and cut through cartilage, pushing the two halves apart.

(g) Starting at the neck, remove the viscera, including the trachea, esophagus, and lungs.

(h) By pressing from below, snap out the breastbone or keel.

(i) Halve the broiler.

(j) To quarter, cut from the approximate center of the back line to the rear of the breast meat.

(k) Clean giblets.

Barbecuing broilers. Barbecuing broilers is easy and fun. It makes delicious food, and is adaptable to family use or for serving a few or many guests. A barbecue pit that will accommodate up to 20 broiler halves is simple to construct. Cinder blocks 8 by 8 by 16 inches are laid in a square, 2 blocks wide, long, and high, with welded wire of 1-inch or 2-inch mesh laid on top. (See *A* of Fig. 126.) For larger barbecues, the same kind of construction can be expanded (*B* of Fig. 126).

Table 15 shows the essential requirements for preparing barbecued broilers for 5 to 300 people.

Table 16. Requirements for Barbecuing Broilers

	Number of Persons						
	5	10	25	50	100	200	300
Barbecue sauce:							
Cooking oil (any)	$\frac{1}{2}$ pt.	$\frac{1}{2}$ pt.	1 pt.	1 qt.	2 qts.	4 qts.	6 qts.
Vinegar (cider)	$\frac{1}{2}$ pt.	1 pt.	1 qt.	2 qts.	4 qts.	8 qts.	12 qts.
Salt	2 tbs.	4 tbs.	$\frac{1}{2}$ cup	$1\frac{1}{2}$ cups	3 cups	6 cups	9 cups
Pepper	$\frac{1}{4}$ tsp.	$\frac{1}{2}$ tsp.	$1\frac{1}{2}$ tsp.	$2\frac{1}{2}$ tsp.	5 tsp.	2 tbs.	3 tbs.
Poultry seasoning	$1\frac{1}{2}$ tsp.	3 tsp.	7 tsp.	4 tbs.	$\frac{1}{2}$ cup	1 cup	$1\frac{1}{2}$ cups
Eggs (well beaten)	1	1	2	3	10	20	30
Pails for sauce	1	1	1	1	2	3	4
Brushes or swabs for basting	1	1	1	1	2	3	4
Forks to turn chicken	1	1	1	2	4	8	10
People to turn and baste chicken	1	1	2	4	6	11	14
Charcoal (pounds) ¹	3	5	13	23	50	100	150
Low kindling (bundles) ²	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	2	4	4

¹ If charcoal briquettes are used, less will be needed.

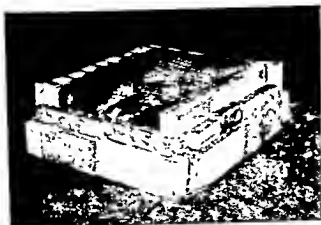
² Grass may be substituted.

To prepare the barbecue, the procedure described here may be followed regardless of the size of the operation.

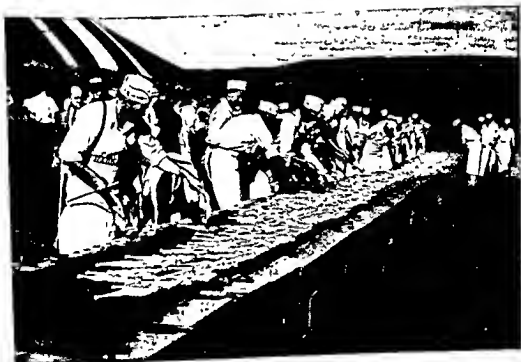
(a) Dress the broilers, weighing about $2\frac{1}{2}$ pounds alive, and halve.

(b) Prepare the sauce. The sauce shown in Table 15 has proved satisfactory. Beat the egg or eggs, add the oil, beat again, add the other ingredients, and stir.

(c) Start the fire 20 to 30 minutes before broilers are put on. Crumple newspapers and distribute over the bottom. Scatter wood kindling and ignite. (Too much kindling may give too hot



A



B

FIG. 126. A. A homemade barbecue pit for 10-20 people. Cinder blocks are placed on the ground end to end. A few 8"-wide blocks and ordinary bricks can be used effectively. B. Cinder blocks and pipe to support the wire are in use here to serve a large group. An improvement on this plan, widely used to more quickly turn the birds, is to make frames 2' to 3' wide to lay across the pit. To turn, an empty frame is placed over a filled one. Two men, one on each side of the pit, grasping two pipes in each hand, can turn both the filled and the empty frames together. The top frame, now empty, is used to turn the next filled frame, and so on. Photographs courtesy Cornell University.

a fire.) In 2 or 3 minutes, place the bag or bags containing the charcoal on the burning kindling. As the bags burn, they release the charcoal. Charcoal briquettes are often used. Because they burn hotter and longer, less are needed. Gasoline sprinkled from a can directly on charcoal and then ignited may be used instead of kindling. It is, however, more dangerous, as the match must be thrown in from a distance.

(d) When the coals are hot but not flaming, put the wire in place, dip the halved broilers in the sauce, and place them on the wire.

(e) Turn the birds every 5 to 8 minutes, basting with sauce at each turning and between turnings if the broilers appear dry. Turn more frequently if the birds are cooking too fast.

(f) Cook, turning and basting, for 45 minutes. The skin should be crisp and brown but not burned. *Caution:* A sprinkling can of water should be on hand to use if the fire gets too hot. Sprinkle just enough to reduce the flame.

Serve $\frac{1}{2}$ broiler to an adult, and $\frac{1}{4}$ to $\frac{1}{2}$ to a child.

10. Deboning

For private or family use, a carcass may be deboned. This is done by turning back the flesh, starting from the front, and gradually cutting all the flesh loose from the bones. After stuffing and roasting, slices of both light and dark meat and dressing may be cut.

11. Home canning poultry

Cull hens may be preserved for home use by canning. The canned meat retains its flavor.

Cut the chickens as for fricassee so that they will easily go into the jars. The flesh may be removed from the bones or not, as desired. Seasoning, such as celery leaves, onion, pepper, etc., may be added. Fill the jars to within $\frac{3}{4}$ inch from the top. Add 1 teaspoonful of salt for each pint. No water is necessary. Use new rubbers. Put the cover in place and partly seal.

Pressure cooker. Use a pressure cooker for most satisfactory results, following directions that come with the cooker. Generally, processing at 15 pounds pressure for 80 minutes is recommended for quart containers.

Hot water. Put the jars in the canner, in cold water. The water in the canner should not rise above the rubbers. Cook the jars of

chicken 4 to 5 hours, counting from the time the water commences to boil. At the end of this time, remove the jars and seal.

12. Preparing poultry for the freezer

Recently the advantage of frozen food has been available to both city and country consumers by means of freezer locker plants and home freezers.

Prepare the poultry as follows:

(a) Dress and draw for roasting, or cut up as desired.

(b) Wash the carcass thoroughly inside and out.

(c) Wrap the giblets by themselves. Place inside the carcass or close beside it.

(d) Wrap the entire carcass.

Professor R. C. Baker, Department of Poultry Husbandry, Cornell University, states:

Freezing keeps meat in its most natural form, and does not materially affect the taste of poultry or its nutritional value. Every precaution should be taken to prevent rancidity and freezer burn. Rancidity is caused by the contact of air with the poultry fat and gives a very disagreeable taste. Freezer burn is the result of desiccation of the skin and flesh which results in a loss of water. It first appears around the feather follicles and gradually spreads to the rest of the carcass. If severe, it causes the carcass to become flavorless and tough.

Such wrappings as cellophane, locker paper, and butcher's paper are economical and satisfactory for home use if the poultry is not to be stored over 3 or 4 months. All three of these materials are easily ripped and should be protected with stockinet. Locker paper or butcher's paper should be waxed at least on one side. The waxed side should be placed next to the carcass. If freezing for a longer period of time than 3 months, use wrapping materials such as Pliofilm, polyethylene, Cry-O-Rap, or aluminum foil.

Discoloration of poultry meat is due to slow freezing. When poultry is frozen slowly, large crystals are formed which cause the carcass to appear darkened. Fast freezing forms small crystals and the carcass appears light. This principle can be demonstrated by taking a large piece of ice and crushing it. When ice is broken into small crystals, it appears snowy white; in larger pieces it has a translucent look.

Carcasses should not discolor if a temperature of -20 degrees F. is used with a blower or circulating air. Metal freezer plates, such as those found in home refrigerators, are a satisfactory substitute for circulating air if the meat is close to the metal. Without circulating air or metal freezer plates, warm air is likely to remain close to the carcasses, acting as insulation and preventing fast freezing. It is important to make sure that the temperature is -20 degrees F. *at the time of freezing*. Many people set the freezer for -20 degrees when it is empty; when warm carcasses are added, the temperature may go as high as $+20$ degrees.

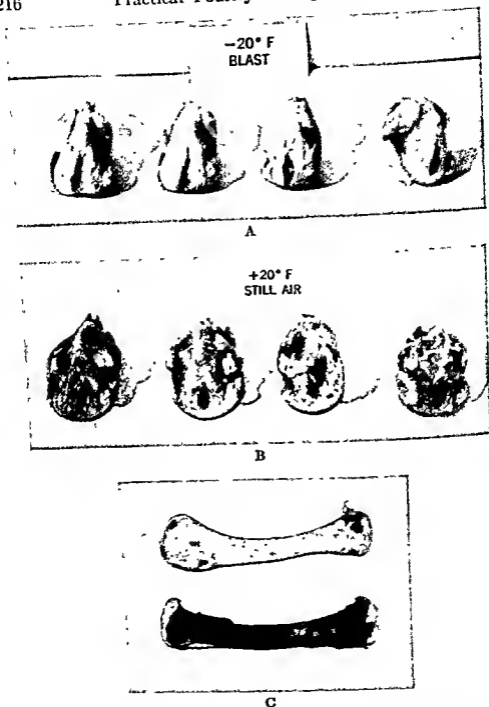


FIG. 127. A. Broilers frozen at -20°F . Note the light color. B. Broilers frozen at $+20^{\circ}\text{F}$. This discoloration is not appealing. C. These two bones are from the same broiler. The dark one is from the half of the broiler that was frozen. The light bone was taken from the fresh half. Courtesy Professor R. C. Baker, Cornell University.

Bone discoloration. In young poultry, the bones are likely to become discolored during the storage period in the freezer. The blood pigment from the internal part of the bone penetrates through because there is not enough calcium on the bones to stop it. In older chickens, such as roasters and fowl, the bones are entirely calcified and the pigment does not penetrate through. Freezing is usually given as the cause for bone discoloration. However, if fresh unfrozen young carcasses are kept for several days, the bones will also discolor. Bone discoloration does not affect the flavor of the meat.

13. Caponizing

A capon is a male bird with the reproductive organs removed. It bears the same relation to a cockerel as a steer does to a bull, a wether to a ram, or a gelding to a stallion.

Capons are preferred by many average-sized families when high-quality poultry meat is to be served. The quality of flesh is unsurpassed, and capons are often quoted at the highest poultry meat prices.

Producing and selling "started capons" is a new and profitable business in certain sections. Cockerels are caponized at 2 weeks of age and shipped to customers at 3 to 4 weeks. Nearly all breeds are likely to be in condition for caponizing at the age of 2 to 4 weeks.

For best results with all breeds, the testicles should not be much larger than a kernel of wheat when the operation is performed.

Either too much or too little light is unsatisfactory for operating. Direct sunlight is dazzling, and a better view of the interior of the body may be had by keeping under the shade of a tree or just inside a barn or other building, where the direct sunlight cannot shine on the bird. If in a building, stand in a position which allows the light (but not sunlight) to shine into the body of the bird. On a cloudy day or when the sun is not bright, the best place may be out of doors. A very cloudy or a dark day is likely to make the operation impossible without arranging a light to shine into the opening.

Instruments and preparations for caponizing are shown in Fig. 128, and the operating procedure is demonstrated in Fig. 129.

After operating, remove the capons to a clean, airy, well-lighted house, the floor of which should be covered with a clean litter. Perches, feed hoppers, and water or milk containers all should be low. The birds should have free range, but other cockerels should be kept separated from them.

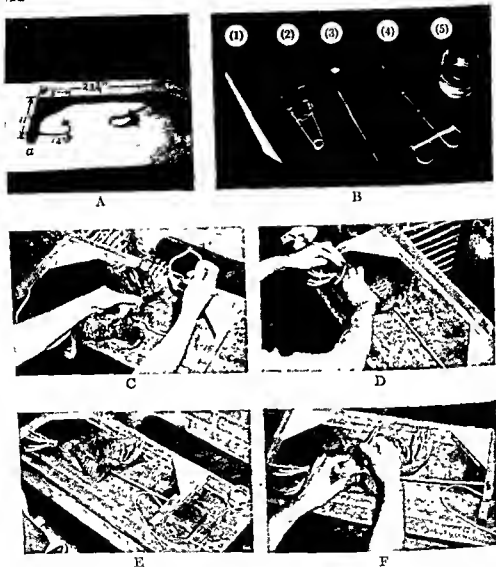


FIG. 128. Equipment and preparation for caponizing. *A* The caponizing frame (designed by F. E. Andrews, Cornell University). *B* The caponizing instruments, general type used. Spreaders and removers vary; the remover shown here is known as the "Farmer Miles." This set has been in use for forty-five years and is still in excellent condition. (1) Knife, (2) spreader, (3) hook, (4) remover, (5) disinfecting solution. *C* Placing the bird in the frame. The loop is placed over the wings, pushed close to the body, and drawn until snug. *D* Grasp the legs firmly with the right hand, upper leg to the rear of the lower. The leg thong is carried under and over the legs, catching the wooden block between legs and thong. *E* The bird is stretched by pulling on the wing thong and catching it under the cleat. *F* The point of the knife is inserted between the two rear ribs.



FIG. 129. Steps in caponizing. *A.* Using the hook to tear the tissue covering the intestines. *B.* Note position of the upper testicle. *C.* Note upper testicle. The lower testicle is grasped by the remover, and is ready to be torn loose. *D.* Removing the testicle. Note the cords and tissues connecting the testicle with interior. These should be removed or cut off. *E.* The operation completed. The cut into the body is covered.

For several days after the operation some capons may develop a "windpuff" on the side of the incision. This is due to the air sacs being cut and not healing as they were before. Air is drawn in but cannot be expelled. To prevent the bird from becoming deformed, puncture the swelling with the point of a knife and allow the air to escape. It may be necessary to repeat this operation at intervals of from 2 to 3 days.

If birds are not marketed alive, they may be prepared in the usual way, either dry-picked or by the hot-scald, subscald, or semi-scald method.

Market quotations on capons usually commence in late October and are discontinued during May. The highest prices are from February to April. These quotations are several cents higher per pound throughout the year for capons of all sizes than are those on cockerels or hormonized chickens weighing $6\frac{1}{2}$ pounds. An exception is the 5- to 6-pound capon, which during February, March, and April is exceeded from 1 to 7 cents by the hormonized $6\frac{1}{2}$ -pound chicken. For any but the small capon, there may be a price advantage to caponizing rather than hormonizing. Hormonized chickens exceed the quotations on ordinary cockerels throughout the year. During most of the capon season, quotations on dry-packed and iced capons are approximately the same.

Capons of American varieties should weigh from 7 to 9 pounds at 6 to 8 months of age, and will require 7 to 10 pounds of grain and mash per pound of weight, depending on the time kept and the age caponized.

In general, one may find more profit in marketing surplus males as broilers. If males are to be held several months for a special trade, the higher value of capon meat per pound, coupled with the greater ease and convenience of keeping them as compared with males not caponized, favors the practice of caponizing.

14. Hormonizing

A method of securing results similar to caponizing is referred to as the chemical method. For this purpose, a synthetic estrogenic hormone called diethylstilbestrol (stilbestrol) is currently used. It may be purchased as pellets or semiliquid paste. Both forms have been approved by the Food and Drug Administration of the Federal Government.

Inserting the pellet or paste. The hormone is placed under the skin on the head, just below and to one side of the comb. Since

the head is not eaten, no harmful effects will result to humans if the bird is dressed before the pellet or paste is fully dissolved. A small hand-operated device is used to implant the pellet or paste.

Breeds. Any breed may be hormonized. Often both pullets and cockerels are treated.

Effect. Feed consumption is stimulated immediately, and fatty materials are increased in the blood and deposited in the tissues much more quickly than in a capon.



FIG. 130. Hormonizing. Injecting the pellet.



FIG. 131. Hormonizing. An instrument in position for injecting paste.

The stilbestrol affects the pituitary, a small gland at the base of the skull, shutting off certain secretions there. This in turn reduces secretions of a hormone in the testes, causing the bird to assume female or capon characteristics. The comb and wattles shrink and become pale and dry, similar to those found in a capon. The normal effects of hormonizing wear off after 4 to 8 weeks.

Practical use. Leghorn cockerels hormonized at 6 weeks with paste or at 3 to 4 weeks with pellets, and slaughtered at 9 or 10 weeks, assume characteristics similar to White Rocks, and are excellent as barbecued chickens or for other broiler purposes.

Recently, best returns on the quoted market for hormonized chickens were from fryers or small roasters weighing about 6½ pounds. Implanting a pellet 4 to 6 weeks before the bird is to be marketed will suppress fighting somewhat and give an appearance resembling true capons in size of comb. A pellet may be given at 7 to 9 weeks and again 4 to 6 weeks before marketing. Young birds to be marketed heavier than 7 pounds should be caponized surgically for best returns and lasting effect.

The primary advantage of hormonizing is that birds finish off faster and at almost any age, whereas for capons one has to wait until nature takes her time in natural growth and physical changes.

General Information

STANDARDS FOR QUALITY OF INDIVIDUAL DRESSED CHICKENS

1. Classes of chickens *

Fryer or broiler. A fryer or broiler is a young chicken (usually under 16 weeks of age), of either sex, that is tender-meated with soft, pliable, smooth-textured skin, and flexible breastbone cartilage. Hormonized fryers have been treated with synthetic female hormones and show evidence of this treatment.

Roaster. A roaster is a young chicken (usually under 8 months of age), of either sex, that is tender-meated with soft, pliable, smooth-textured skin, and breastbone cartilage that is somewhat less flexible than that of a broiler or fryer.

Capon. A capon is an unsexed male chicken (usually under 10 months of age) that is tender-meated with soft, pliable, smooth-textured skin.

Stag. A stag is a male chicken (usually under 10 months of age) with coarse skin, somewhat toughened and darkened flesh, and considerable hardening of the breastbone cartilage. Stags show a condition of fleshing and a degree of maturity intermediate between that of a roaster and a cock or old rooster.

Hen, or stewing chicken, or fowl. A hen, or stewing chicken, or fowl, is a mature female chicken (usually more than 10 months of age) with meat less tender than that of a roaster and with nonflexible breastbone.

Cock, or old rooster. A cock, or old rooster, is a mature male chicken with coarse skin, toughened and darkened meat, and hardened breastbone.

2. Disqualifications

Poultry carcasses which show the following conditions cannot be given any quality designation: dirty head; bloody head; dirty carcass; bloody carcass; dirty vent; dirty feet; fan feathers on the wing tips; garter feathers; and, if the crop is not removed, feed in the crop.

Dressed and ready-to-cook poultry showing the following external condition factors cannot be given any quality designation: extreme emacia-

*The U. S. Department of Agriculture, through the Poultry Branch of the Production and Marketing Administration, issues from time to time complete up-to-date material on standards of quality and grades of various kinds and classes of poultry. Only those for dressed chickens are summarized here, taken from the *Poultry Grading Manual*, February 1932. Those desiring more information may write the above. A small charge may be made for various publications.

tion; obvious evidences of disease; abdominal accumulations; evidences of anemia; bruises in excess of those permitted in C Quality birds; combs and wattles shrunk or engorged with blood and dark red or purplish color; skin and flesh appearing doughy. Anemic birds are identified by abnormally pale carcasses

3. Quality factors

Conformation. In the standards of quality for poultry, the terms *normal*, *practically normal*, and *abnormal* refer to A Quality, B Quality, and C Quality, respectively.

Normal may have a slightly curved breastbone or other slight abnormality in shape. May also have a slightly curved back or a slight dent in the breastbone if this deformity does not exceed $\frac{1}{8}$ of an inch.

Practically normal may have abnormalities such as a dented, curved, and slightly crooked breastbone, a moderately crooked back, misshapen legs, and misshapen wings.

Abnormal has serious abnormal physical conditions, such as a crooked or peaked breastbone or a crooked or hunched back, or other serious deformity. Such carcasses are permitted in C Quality if they are at least fairly well fleshed.

Fleshing. One of the most important factors of value and quality is the amount of flesh that is on the carcass in relation to its skeletal size and age.

A Quality. A well-developed, moderately broad, long breast, well-fleshed throughout its entire length, with flesh carrying well up to the crest of the breastbone so that the breastbone is not prominent. The legs shall be well covered with flesh.

B Quality. Sufficiently well fleshed on the breast and legs to prevent any appearance of thinness and prominence of the breastbone.

C Quality. Poorly fleshed.

Fat covering. Perhaps the most important factor of quality from the standpoint of excellence of flavor, texture, and tenderness is the amount of fat covering or "finish" that is present in a poultry carcass.

A Quality. Well covered with fat over breast, back, hips, and pinbones, except that chicken broilers or fryers may have only a moderate amount of fat covering these parts. A hen, stewing chicken, or fowl, although well covered with fat, is free from excessive abdominal fat.

B Quality. Sufficient coverage of fat on breast and legs to prevent a distinct appearance of the flesh through the skin.

C Quality. May be lacking in fat covering over all parts of the carcass.

The determination of the amount of fat covering that is present in a carcass is one of the most difficult decisions that the inexperienced grader has to make. The amount of fat that is required for A Quality varies considerably with the kind and class of bird. A well-finished broiler, for instance, may appear to have a relatively small amount of fat in comparison with that of a roaster or hen.

Fat is deposited in the skin and between skin and flesh of the bird in certain definite areas. There is a rather noticeable layer of fat along the two main feather tracts. There is also a layer of fat (fat collar)

around the crop and area at the fore part of the breast. If the fat collar is fairly well defined in a broiler or fryer, the bird may be considered to be well covered with fat. Many graders use this particular indicator almost exclusively in judging the fat covering or finish of poultry. Along the feather tract down the middle of the back is usually the last area on the bird where a layer of fat is put on; therefore, this layer is a good indicator of the general fat covering of the bird.

Freedom from pinfeathers. The presence of pinfeathers on dressed and ready-to-cook poultry is considered one of the more important quality defects by many consumers. Pinfeathers are of two types, those that protrude and those that do not. Vestigial feathers, hair in the case of chickens and turkeys, and down in waterfowl, are also considered quality factors. Slightly more pinfeathers are permitted on dressed poultry than on ready-to-cook poultry.

A Quality. Practically free of pinfeathers, especially on the breast; free of vestigial feathers. A ready-to-cook carcass is free of protruding pinfeathers, practically free of nonprotruding pinfeathers, especially on the breast, and free of vestigial feathers.

B Quality. May have not more than a slight scattering of pinfeathers over the entire carcass and only relatively few on the breast, and is free of vestigial feathers. Ready-to-cook poultry is free of protruding pinfeathers and vestigial feathers, and may have not more than a few scattered nonprotruding pinfeathers.

C Quality. May have numerous pinfeathers and vestigial feathers scattered over the entire carcass. A ready-to-cook poultry carcass is free of protruding pinfeathers and vestigial feathers, and may have nonprotruding pinfeathers only to the extent that they do not seriously detract from the appearance of the carcass.

Freedom from cuts, tears, and broken bones. No sewn tears are permitted in any quality of bird. However, wing tips may have been removed.

A Quality. Free of cuts and tears on breast and legs. Elsewhere on the carcass such defects may total $1\frac{1}{2}$ inches in chickens. No broken bones. May have one disjointed bone in either a leg or a wing if there is no evidence of a related bruise or blood clot. A chicken broiler or fryer may have one nonprotruding broken bone in the wing in addition to such disjointed bone, but only if there is no evidence of a related bruise or blood clot.

B Quality. May have cuts and tears on the breast, the aggregate length of which does not exceed $1\frac{1}{2}$ inches, and elsewhere on the carcass if they do not exceed 3 inches. May have no more than two disjointed bones in either the legs or wings or both, but only if there is no evidence of a related bruise or blood clot; may have one broken bone in legs or wings if such bone is nonprotruding and does not show an excessive related bruise or blood clot.

C Quality. May have torn skin, disjointed bones, and broken bones, but only if there is no evidence of a related severe bruise or blood clot.

Freedom from discolorations of skin and from flesh blemishes and bruises. Discolorations and blemishes occur before and during the dressing opera-

tions and are largely due to rough handling. Discolorations, abrasions, and other slight blemishes caused by poor dressing technique detract from the general appearance of the carcass. However, recent surveys indicate that most consumers do not consider these blemishes very important quality factors when purchasing poultry if the skin is kept fairly moist or if the carcass is packed in moisture-repellent containers. Bruises, on the other hand, occur prior to dressing and are caused largely by rough handling during transportation of the poultry from the farm to the dressing plant. Bruises, particularly of the flesh, are an important quality factor and detract from the appearance and sales value of the carcass.

A Quality. The carcass is free of bruises and discolorations of the flesh on breast and legs. Elsewhere a slightly reddened color is permissible, to the extent of not more than $\frac{1}{2}$ inch in diameter. May have skin bruises on the breast and legs, $\frac{1}{2}$ inch in diameter; elsewhere, to the extent of $\frac{3}{4}$ inch in diameter. Total aggregate area of flesh and skin bruises and other discolorations and blemishes on the breast and legs shall not exceed 1 inch in diameter; elsewhere, $1\frac{1}{2}$ inches in diameter. The skin may show only slight reddening in the feather follicles on the neck near the head and on wings because of improper bleeding.

B Quality. May have flesh bruises on breast and legs, a slightly darkened color area not more than $\frac{1}{2}$ inch in diameter; elsewhere, not to exceed $1\frac{1}{2}$ inches in diameter. Skin bruises on breast and legs $\frac{3}{4}$ inch in diameter; elsewhere, $1\frac{1}{2}$ inches in diameter. Total area on breast and legs of poultry shall not exceed $1\frac{1}{2}$ inches in diameter; elsewhere, 3 inches in diameter. The skin may show not more than moderate reddening in the feather follicles on the neck near the head and on wings and thighs as a result of improper bleeding.

C Quality. May have numerous and large discolored areas or blemishes on the skin, which may be accompanied by some reddening and darkening of the flesh beneath, if such discolorations do not make any part of the carcass unfit for food.

Freedom from freezer burn. The discoloration and drying out of the skin of poultry carcasses during storage is commonly called "freezer burn." This defect detracts from the appearance and sales value of the carcass and also lowers the quality, in the case of either moderate or severe freezer burn.

A Quality. Only slight burn or evidence thereof. A few pockmarks not exceeding $\frac{1}{8}$ inch in diameter are considered slight freezer burn.

B Quality. May show moderate freezer burn on any part of the carcass, but may have no dried areas in excess of $\frac{1}{2}$ inch in diameter.

C Quality. Shows more than moderate freezer burn and may have numerous pockmarks or large dried areas on any part of the carcass.

4. Grades of dressed and ready-to-cook chickens *

The difference between standards of quality and grades is sometimes not understood. Standards of quality refer to the quality evaluation of an individual bird. A bird may be classified as A, B, C, or as a reject.

* Federal grades and regulations are used in larger plants. Smaller plants often use state suggestions when available.

Grades usually apply to wholesale lots of poultry, although a grade may be properly applied to an individual bird, in which case "grade" and "quality" would be synonymous. For example, an A Quality bird may properly be labeled U. S. Grade A and sold as such.

Dressed and ready-to-cook poultry is handled, sold, and traded commercially on the basis of lots. A lot consists of one or more containers which usually hold 12 birds, although many processors pack from 4 to 20 or more birds in a container, depending, of course, on the type of container and the class and size of poultry packed.

Poultry processors generally grade their products on the basis of U. S. standards of quality and frequently label packs with brand names representing qualities comparable to U. S. A, B, and C qualities or various combinations of these qualities.

Since there are human as well as natural elements of variation, grades are set up with tolerances. In the U. S. grades for dressed and ready-to-cook poultry, any lot of birds composed of one or more containers of the same kind and class of poultry may be designated as U. S. Grade A if at least 90 per cent of the birds are of A Quality and the remainder are of B Quality, and no individual container in the lot contains more birds of B Quality than in the proportion of 2 to each 12 birds in the container. The same applies to B Quality, using C Quality as the tolerance. Any lot of poultry may be designated as U. S. Grade C if it consists of birds of not less than C Quality.

The tolerances provided for in the U. S. grades are applicable only when the individual birds in the lot are not marked with a U. S. grade. When individually grade marked, each bird in the lot must be of the quality shown in the marked grade.

Community Survey

Talk with the poultrymen of the neighborhood about the marketing of surplus poultry and obtain answers to the following questions.

1. What class of poultry is marketed?
2. How is poultry prepared for market? Alive, dressed, drawn, ready-to-cook, other?
3. What influence does class have on method of preparation?
4. Why do they prefer to market as they do?
5. What influence does the price received have on the method of marketing poultry?
6. What influence does labor have on the method?
7. At what age are the different classes marketed?
8. When is the Market Best for the classes sold?
9. Which of the classes of poultry sold are grown for meat sales only?
10. Which are sidelines to egg production?
11. Draw a plan of a killing room in the community, showing location of equipment and dimensions.
12. Redesign the plan, giving attention to saving steps and labor.

13. What types of picking machines are used?
14. Which methods of picking poultry are used?
15. Ask the older people of the community how chickens were killed and dressed years ago.
16. What is the cost of shipping poultry to market?
17. What are the regulations governing the shipment of poultry?
18. What suggestions can you give to improve the methods in use?
19. What is the status of frozen poultry in the community? Are locker plants and home freezers in use? How is poultry prepared for freezing?
20. What is the status of caponizing, hormonizing, selling on the basis of standards and grades?

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Keeping Records of the Flock

To be well balanced, a poultry enterprise needs sufficient records available at all times to enable the operator to determine the results of his labor and to help him make reasonable decisions on immediate and future operations.

Is my brooding operation sound or am I losing too many chicks? Will there be enough good pullets to meet my needs? Are my hens laying as they should or is the flock dropping in production? Is this change in production a normal variation? I'll watch it for a day or two to see whether it is serious. Does my egg price check with quotations? If not, is there a quality problem? How do my egg and feed prices check with a month ago? Is this normal? How do they check with last year? Is my cash balance satisfactory? Should I borrow some cash or can I expect my enterprise to straighten out the matter? What changes in management, based on my results the past year or two, will likely make my enterprise more profitable?

A single enterprise account provides information to study the business from several angles. It should give at a glance the data needed to answer many of the above and other questions. Records eliminate much of the guesswork and, by providing facts, relieve the mind and increase the enjoyment of the work or produce the incentive to correct matters in need of correction.

Keep poultry records. Secure a single-entry book and the necessary pen sheets from your state college or county agricultural agent. They are usually available at a very nominal charge. It may prove to be a most satisfying investment.

Operations:

1. Keeping the egg record.
2. Keeping the flock record.
3. Keeping the brooder record.
4. Keeping the financial records.

1. Keeping the egg record

Regardless of the number of records kept, no poultry enterprise, whatever its size, should be without a record of the daily egg production.

Using the sheet. Place a record sheet in each house or pen. Tack a string and pencil, with eraser, to the wall near the sheet. Count the eggs as gathered, and record as soon as the job is completed. A sheet to record 2 to 4 collections and the total daily is preferable.

Dates and name of the house or number of the pen are very important for later reference.

Importance. The egg record shows variation in production, and gives information as to whether the change is normal or serious. It serves to check the influence of disease, weather conditions, and general care on production, and is used as a basis for flock improvement. It also creates and stimulates interest in better management.

2. Keeping the flock record

A place to record losses or additions to the flock is usually provided on the egg record for each month.

Importance. By this record the number of birds in the flock is shown at any time. It shows when mortality occurred, gives a record of culling, and, with the egg record, provides a means of finding the per cent production during any month or period of time.

3. Keeping the brooder record

A record should always be kept of the number of chicks placed under a hover, the date hatched, the mortality each day, and birds sold, used, or kept.

Using the sheet. A sheet for each flock is desirable. If a hatch is divided among several small hovers, one record for the entire batch may be sufficient.

BROODING AND GROWING MORTALITY RECORD¹195] Name of Operator Form 63

YEAR 1951-1952

Breed of Poultry SC White Leghorns

DIESEL PLACES IN HOUSES		NUMBER OF BIRDS LOST				
DATE	NUMBER	DAYS	JAN	FEB	MAR	APRIL
Nov 28	1052 H/L	1	1			1K
	36RRX	2			1	
	9 AM	3			3K 2K	
TOTAL		4		1		
CLOCKED ONLY ON DATES		5				
DATE	NUMBER			1 Small		
3/29	1	7		3 Zero Night		1
		8		2		1K
		9		2		
		10		1		
		11				
		12				
		13			1	
		14				
		15	1			
TOTAL		16		1K 2		
PALETS SOLD IN CAGE		17		6		1
DATE	NUMBER	18		2	2	1K
4/20	4	19		1K broken leg		
		20			1K	4 used
		21			1	
TOTAL		22		1		
PALETS PLACED IN WING HOUSES		23	1			1K
DATE	NUMBER	24				
2/16	390	25		2K small	1K	
Copons 4		26	1	1K lame		
		27		1		
4/21	565	28			1K	
Copons 23		29	1		1CN	
		30	12		6K small	
		31	2			
TOTAL		TOTAL	19	2K 23	20 (1 condani)	4x4

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		1	
		15	15 3x

¹ Prepared by State York State College of Agriculture at Cornell University, Ithaca, N. Y.

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Importance. The brooder record shows the mortality, the cause if known, and the number of chicks on hand at any time. It may call attention to a faulty management practice before it becomes serious.

4. Keeping the financial records

On most farms, poultry is kept for financial gain. The best results can usually be accomplished, and the facts of the business most clearly known, when a system of accounts is kept.

Poultry keeping is a business involving many financial and other details. No business can be efficiently managed without keeping adequate records to support one's memory.

Single-entry system. The single-entry system of bookkeeping is best for an enterprise such as market egg production or broiler, hatching egg, or pullet production. If several of these enterprises are conducted at the same time, a more elaborate set of accounts

may be needed than the one explained in these pages. By the use of a single-entry system, a record is kept of all income and outgo. From it a person can find the gain or loss; the amount and the cost of grain and mash consumed; the number of eggs sold, consumed at home, or used for incubation; the causes of gain or loss; and other information of interest and value.

The inventory. The inventory for a poultry enterprise consists of everything used for or by the poultry flock, either the whole valuation or the proportionate share, with a value assigned to each article. This is essential in any type of accounts. An inventory may be taken of the entire enterprise, the laying flock, or the rearing flock, depending upon the study to be made.

Taking the inventory. Make a list, in a book, of the items suggested in Table 16. Leave space between for other items found. Take a pencil and the list and go over the plant systematically. Enter the number of each item found and estimate its value. The basis for estimating values should be the value which would probably be received for the article at the farm, if there were plenty of time in which to make a sale.

At the end of the account year, use the same list and make the rounds of the plant as before, adding to or subtracting from the list as the case may be.

After the first year, taking an inventory requires only a short time.

The depreciation charge. (a) Items may be entered in the last inventory at a certain percentage less than in the beginning inventory; or (b) items may be entered at their value in both inventories, the percentages applied to the average of the inventory items, and the result entered as an expense (debit). Common depreciation percentages are 3 on buildings, 10 on portable colony houses, range shelters, and fences, and 8 on other equipment.

When repairs are made during the year, increase the value at the last inventory [under (a) above] after the depreciation has been figured; or [under (b)] the depreciation charge in the expenses may be decreased accordingly.

Value of inventory. The inventory shows the amount of money invested in the enterprise. It serves to call attention to the condition of equipment and to repairs that should be made; it is also a reminder of tools which have been lent or borrowed and not returned, or that have been misplaced.

A sample inventory. The best time to take an inventory is when there will be the least figuring involved, and at the logical time for closing the year's business. For the poultry enterprise examined here, May 1 was the date the inventory was taken. In the following analysis (Table 16), figures are taken from a single-entry

Table 16. Inventory to Determine Cost of Producing Eggs, Farm 63¹

(S. C. White Leghorns)

May 1, 1951

April 30, 1952

Item	No. or Lb.	Price	Value	No. or Lb.	Price	Value
Stock *						
Pullets	951	\$2.00	\$1902.00	...	.....	.....
Hens	376	1.25	470.00	562	\$1.25	\$702.50
Hens (2nd yr.)	302	1.00	302.00	302	1.00	302.00
Feed						
Grain	400	4.00	16.00	400	4.00	16.00
Mash	300	4.50	13.50	300	4.50	13.50
Grit and shell	200	1.00	2.00	200	1.00	2.00
Litter			15.00			15.00
Eggs on hand			.....			.....
Equipment and supplies						
Watering system			125.00			112.50
Egg cases			50.00			50.00
Shipping coops (3)			6.00			6.00
Cleaning equipment			3.00			3.00
Feed, bins, tank, etc.			30.00			27.60
Feed hoppers (22)			55.00			50.60
Elevator			10.00			9.00
Wheelbarrows (3)			15.00			13.80
Egg pails			10.00			9.00
Egg sizer			75.00			69.00
Egg washer			140.00			126.00
Egg hatchet, tools			1.75			1.75
Laying house			3000.00			2910.00
Storage space			300.00			291.00
Egg room			200.00			200.00
Total investment			\$6741.25			\$4930.25
				Decrease in in- ventory		\$1811.00

¹ This inventory is for a laying flock only. Rearing inventories are not included. See pages 243 and 244 for example of finding rearing costs.

² Inventory stock at the price they normally would have sold for on the farm

set of accounts kept by the owner of Farm 63. The other labor used was engaged in other lines of work. The owner at times took part in all phases, but in general his main responsibility was the entire care of brooding; ordering chicks, all feed, and any other items; supervision of the entire enterprise; keeping and summarizing the accounts; and packing the eggs. The other labor cared for the adult stock; did the feeding; gathered and recorded eggs; cleaned, sorted, and packed the eggs when the owner was away. Sexed chicks were purchased, feed was ordered and delivered by a nearby co-op. Eggs were sold to a marketing co-op, whose truck came to the egg cellar, took the cases of eggs, and left empty cases for next week's eggs and the check for the eggs of the week before.

Saving labor, consistent with meeting the needs of the poultry and the other demands on the time of the labor, was a keynote on this plant. Therefore, the following practices were used: free-choice grain and mash feeding, which permitted filling feeders at any time day or night; all-night lights; automatic waterers; built-up litter, compost or reused litter for the layers for several years; night culling of hens; night transfer of hens and pullets to barracks and laying houses, respectively; and confinement rearing. For many years the manure was sold or traded for chick litter or for other work about the plant.

Three persons took part in the regular care, the owner and a man and his wife.

The charge or debit. A record must be kept of every purchase. The principal item will be feed, but there are a great many other items for which cash will be spent during the year. A record should be made when these articles are purchased so that they will not be forgotten. These items include disinfectant, litter, fees for various purposes, taxes, insurance, egg cases, equipment purchased, delivery, trucking, and many other things.

The poultry credits. The credits include all transactions in which anything of value is disposed of. They may include eggs or poultry sold, used, or given away, feed bag refunds, patronage dividends, manure sold or used on the farm, equipment sold, etc.

The records may be filed away and worked up as time permits.

The summary. Each month the totals of expenses (debits) may be transferred to a similar sheet with one line for each month. The amount and value of each item (grain, mash, chicks, etc.) can be compared easily any time. A quick summary of income versus

POULTRY EXPENSES

Include here as expenses all home-grown food and labor used for poultry. Other purchases and expenses (columns 5 and 6)

Date	1 Quantity	2 Kind of Expense	3 Value	4 5 6 LAYING FLOCK			
				Grain	Mash	Grit Shell Others	Deliv- ery
7	4	25 lb bulbs					
8		Labor, cleaning brooder					
10	700	Whole corn	4 70	32 90			
	800	Wheat	4 10	32 80			
	400	Oats	3 90	15 60			
	800	Mash	5 35		42 80		2 33
	200	Starter mash	5 50				
	80	Grit				1 00	

26	60	Gal kerosene	15				
31	800	Whole corn	4 65	37 20			
	800	Wheat	4 10	32 80			
	100	Oats	3 80	3 80			
	600	Mash	5 55		32 10		2 17
	600	Starter mash	5 50				
Total				342 10	181 90	3 58	9 60

expenses thus far in the record year is then possible. The same procedure should be followed with the income (credits).

In order to have the information available for use in the next year's work, the yearly summary should be made promptly at the end of the year and the labor income on poultry, or the profit, determined.

Keeping a rearing account. For keeping a record with rearing only, the single-entry system may be used. The plan is the same as that just outlined. An inventory of items used during rearing, or a proportionate value of buildings, land, or equipment used, is needed.

A complete record of the debits and credits for the period, including actual or estimated costs of labor, together with the inventories provides the data from which one may figure the cost of producing pullets, amount and cost of feed, and many other items.

Points to have in mind. In a single-entry set of accounts, an entry should not be recorded if a payment is made on a mortgage or bill for anything that has been inventoried. When an item is inventoried it means that the enterprise is charged with that item at the start or credited with it at the end. When a payment on

POULTRY RECEIPTS

Date	1 Dozens of Eggs	2 Size of Eggs	3 Kind of Receipt	4 Price	5 Total Value	6 Eggs Sold	7 LAYING Eggs Consumed at Home
3				\$	\$	\$	\$
4	81	Large		44½¢		3605	
	9	Med.		39½¢	3961	356	
9	4	Cheeks			160	160	
10	141	L.		42¢		5922	
	9	M.		35½¢	6251	329	
17	285	L.		43¢		12255	
	15	M.		36	12795	540	
18							
24	282	L.		43½¢		12267	
	12	M.		37½¢		450	
	6	Cks		20	12837	120	
31	273	L.W.		37½¢		10258	
	6	L.B.		37		222	
	9	Med		33½¢		302	
	9	Cks		20	10942	180	
Total	1141				146946		

Farm No. Name of operator ..
Date of taking record . . . Year record is taken . . .
Size of farm . . . Acres owned Acres rented ..
Kind of animal enterprises kept commercially ..
(Arrange in order of importance)

What cash crops are grown? (arrange in order of importance)

Number of mature birds	...	Breed	...
------------------------	-----	-------	-----

Number of pullets Cocks Cockerels

What per cent of the poultry is marketed alive? Dressed?

Products sold

Amount

Value

Market eggs
-----------------------	-------

Fowls
-------------	-------

Broulers ..

Breeding stock
----------------	-------

Day-old chicks

What per cent of the total farm income is derived from poultry?

Reference

Poultry record books from your state college or agricultural school.

Studying the Records

In Chapter 12 the various operations required to keep a single-entry record on poultry are described. Merely to keep records and accounts is not sufficient, however. They must be analyzed to see how the business prospered and whether it may be improved the following year. At the end of the year it is important for the poultryman to ask and answer four questions:

1. How much is the business making for me?
2. How much have the various departments gained or lost?
3. Why did certain departments fail and others succeed?
4. Where has my money gone?

If a good income was received, it is important to know whence it was derived. A good income from eggs might be due to low cost of production, or to a high average price for a certain period or a particular year, or to all these causes.

Studying records is a good rainy-day job. Keeping and studying records does not *take* time; it *saves* time, by affording short cuts in actual practice.

In this chapter a method of summarizing the data from single-entry accounts will be described.

Operations:

1. Finding the percentage of production
2. Finding the labor income on poultry.
3. Finding the profit on poultry
4. Finding the cost of rearing pullets
5. Finding the cost of producing eggs.

General information:

1. Explanation of cost items.
2. Factors affecting profits

Operations

1. Finding the percentage of production

Both the *flock* and the *egg* records are used in finding the percentage of production.

A simple method is to take the number in the laying flock in the beginning inventory, add any additions during the month, subtract any death losses and those sold or consumed. The result is the number left on the last of the month. The average of the two figures times the days in the month gives the "hen days." The number of eggs produced divided by the hen days and multiplied by 100 equals the percentage of production for the month.

Production per hen per year. Add the number in the beginning inventory to the number of birds in the laying flock on the first day of each month and the number in the flock the last day of the year. Divide the sum of these 13 figures by 13. This equals the average number of hens for the year. Divide the total eggs produced by the average number of hens to find production per hen per year.

2. Finding the labor income on poultry

Labor income may be defined as the proceeds a person receives for his year's work, above all farm expenses and interest on the capital, in addition to having the use of his house and the farm produce for the family. It is what a person receives for his labor. All labor employed or used, except the operator's labor, is included in the farm expenses.

In finding the labor income, therefore, it is customary to include as real estate the value of the dwelling. The results in this record do not include the dwelling or a proportional share of it, as varying residential values would materially influence the results. In this respect the term "labor income" as here worked out differs from "labor income" on the entire farm enterprise; hence, we speak of it as the "labor income on poultry." It deals with one department of a farm business, whether this department be a part or the whole of the business of the farm.

To find the labor income on poultry, three groups of figures are necessary: first, two complete inventories, one at the beginning and another at the end of the year; second, total expenses for the year; and third, total receipts.

Inventories for Farm 63 appear in Tables 16 and 18, plus 955 pullets at \$2.00 each (page 249) grown during the year and ready to lay April 30, 1952. Inventories are used to find the increase or decrease in inventory at the end of the year, and to find the interest on the capital invested.

Stock of the same quality should be inventoried at about the same amount each year. Stock which is held over to later inventories is usually valued less than on the previous inventory.

Referring to Tables 16 and 18, we find inventory totals as follows:

	May 1, 1951	April 30, 1952
Totals for laying flock only	\$6741.25	\$4930.25
Totals for rearing flock only	381.00	548.75
Value of pullets retained (955)		1910.00
	<hr/> \$7122.25	<hr/> \$7389.00
		7122.25
		<hr/>
Increase in inventory		\$ 266.75
Inventory May 1, 1951	\$7122.25	
Inventory April 30, 1952	<hr/> 7389.00	2)14511.25
Average inventory		<hr/> \$7255.63

Table 17 shows the method of arriving at the labor income. In addition, the following were used in the house:

Eggs, 200 dozen	\$ 80.00
Meat, 100 fowl	85.00
4 broilers	1.00
27 capons	21.00
	<hr/>
Value of products used	\$187.00

Plant income is what the poultry keeper receives for his time and the use of his money. Deducting the interest leaves the amount received for his time, or the labor income on poultry. In addition to this figure, he must consider that various products from the plant have been used in the house throughout the year. On a large enterprise, labor income is usually larger than profit, while on a small business the reverse is likely to be true.

Table 17. Labor Income Record, Farm 63¹

May 1, 1951–April 30, 1952

Average capital	\$7255.63	
Receipts:		
Eggs	9826.90	
Poultry	415.14	
Manure	50.00	
Discount	113.31	
Bags	361.37	
Miscellaneous	110.89	
Increase in inventory	266.75	
Total receipts		\$11,144.36
Expenses:		
Feed	6132.54	
Labor, except operators	980.95	
Chicks	367.50	
Taxes	150.00	
Insurance	39.10	
Brooder repairs	200.00	
Water, electricity, telephone	105.00	
Trucking	238.50	
Egg cases	285.45	
Miscellaneous	500.63	
Total expenses		\$8,999.67
Plant income (receipts minus expenses)		\$2,144.69
Interest on average capital, \$7255.63 at 4%		290.23
Labor income on poultry (plant income minus interest)		\$1,854.46

¹ Not including value of dwelling.

3. Finding the profit on poultry

Profit differs from labor income in that in calculating profit the enterprise must receive credit for all products of the plant that have been used by the operator. The enterprise must also pay for all the operator's labor in addition to the other expenses. Profit may be defined as "the return from a business or enterprise or transaction above all costs. The return should include both actual receipts and actual or estimated appreciation on capital involved. The costs should include all actual expenditures and the estimated value of all labor, materials, etc., used; all rents, in-

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	<hr/>	<hr/>
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Bags	361.37	
Miscellaneous	110.89	
Increase in inventory	266.75	
	<hr/>	
Total receipts		\$11,144.36
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Trucking	238.50	
Egg cases	285.45	
Miscellaneous	500.63	
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Total expenses		\$8,999.67
Plant income (receipts minus expenses)		\$2,144.69
Interest on average capital, \$7255.63 at 4%		290.23
		<hr/>
Labor income on poultry		
(plant income minus interest)		\$1,854.46

¹ Not including value of dwelling.

3. Finding the profit on poultry

Profit differs from labor income in that in calculating profit the enterprise must receive credit for all products of the plant that have been used by the operator. The enterprise must also pay for all the operator's labor in addition to the other expenses. Profit may be defined as "the return from a business or enterprise or transaction above all costs. The return should include both actual receipts and actual or estimated appreciation on capital involved. The costs should include all actual expenditures and the estimated value of all labor, materials, etc., used; all rents, in-

terest, insurance, and any depreciation on the capital involved."*

To find the profit on Farm 63, it is necessary to add to the labor income the value of the products used, and deduct the value of the operator's labor (Table 17).

Labor income on poultry	\$1854.46
Value of product used	187.00
Total	<hr/> \$2041.46
Value, operator's labor (estimated)	\$ 558.50
Profit	<hr/> \$1482.96

4. Finding the cost of rearing pullets

In finding this cost, record and proceed as follows.

Take *two inventories*, one at the beginning and one at the end of the year (Table 18). The inventories should include everything used for rearing, but not the value of the chicks themselves. If eggs are hatched in incubators on the farm, the incubators should be inventoried.

Record all *costs of rearing*, including value of hatching eggs, costs of hatching, or chicks purchased.

Record all *returns of rearing*, including cockerels sold, used, or retained. Pullets sold or retained are not considered.

Deduct the *returns from the costs*. This figure represents the *working capital* required to rear the pullets, and none of which is returned to the operator until the pullets are placed in winter quarters.

Charge interest on one-half of the working capital for 6 months at 4 per cent, and add to the working capital. The result is the net cost of rearing.

Divide by the number of pullets reared to find the cost per pullet.

5. Finding the cost of producing eggs

On farms where the rearing expenses, receipts, and inventories are kept separate, the cost is readily found. The necessary steps are:

Inventories. At the beginning and end of the year, take inventories of the capital invested in real estate, stock, equipment,

* From Department of Agricultural Economics, Cornell University.

Table 18. Inventory to Determine Cost of Rearing Pullets, Farm 63

Items ¹	Beginning of Period: May 1, 1951			End of Period: ² April 30, 1952		
	No. or Amount	Price	Value	No. or Amount	Price	Value
Real estate						
Land	...	...	...	...	...	...
Brooder house	1	...	\$300.00	1	..	\$475.00
Range shelter	...	...	...	...	...	...
Barn ³	...	..	..	...	...	...
Equipment, supplies						
Water founts	.	...	18.00	2	..	16.00
Brooder	2	...	15.00	1	...	14.00
Pails	...	..	3.00	..	...	2.75
Feeders	..	...	25.00	4	...	22.50
Oil tanks	...	...	10.00	...	...	9.00
Forks and tools	..	..	5.00	...	...	4.50
Miscellaneous	...	...	5.00	...	...	5.00
Total ⁴			\$381.00			\$548.75

¹ Include everything used for rearing, either the whole valuation or the proportionate share.

² A difference in the totals means an increase or decrease in inventory and will appear in "Returns" or "Costs," respectively.

³ Proportionate share used for storing feed, litter, supplies, equipment, etc.

⁴ Any item appearing in the inventory at the beginning of the period, if still on hand at the end of the period, must not be valued higher at the second inventory than it was at the first, unless special improvement has been made. In this event it must appear as a "cost." Ordinary repairs to equipment or buildings should not add to the inventory value of any item.

and supplies used for the laying and breeding flocks. Rearing inventories are not included.

Costs. These include the value of all materials of any nature purchased or received for the use of the adult flock. They include feed, labor, taxes, insurance, fees, interest on the average inventory, decrease in inventory (if any), and any miscellaneous costs.

Returns. These include all sales from the adult flock except sales of eggs, the increase in inventory (if any), and any mature stock used by the operator's family or given away.

Cost of producing eggs. Deduct the returns from the cost and divide by the number of dozens of eggs produced, as shown by the daily egg record. See Table 20 for method of finding costs.

Table 19. Rearing Pullets, Farm 63—Cost-Returns Summary

Cost			Returns		
Items ¹	No. or Lb.	Value	Items ²	No. or Lb.	Value
Feed, homegrown or purchased			Feed bag refund	229	\$34 35
Grain	11,708	\$482.46	Manure used		15 00
Mash	11,220	526.29	Broilers sold		
Grit	110	1.30	Broilers used	4	1 00
Labor			Roasters sold, used, or retained		
Man hours @ 75 cents	478	358 50	Miscellaneous returns		6 29
Use of auto		2.00	Increase in inventory, if any (Table 18)		167.75
Taxes		10.00	Total returns		\$224 39
Insurance		10 00			
Fees and dues		...			
Brooder repairs		200.00			
Interest on average investment @ 4%		18.60			
Misc. expenses			Summary		
Chicks		367.50	Total cost of rearing		\$2090.71
Fuel (oil), gal.	547	81.64	Total returns (except pullets)		224 39
Litter (est.)		2 50	Working capital (cost less returns)		1866.32
Hauling feed (outside labor)		22.90	Interest on half working capital for 8 months @ 4%		18.67
Disinfectant		..	Net cost of rearing pullets (working capital plus interest)		1884 99
Equipment purchased		2.52	Cost per pullet (\$55 retained, see page 249) ³		1.97
Repairs and depreciation		4.50			
Decrease in inventory, if any		..			
Total cost of rearing		\$3090 71			

¹ Include below everything used for rearing, either the whole or proportionate share.

² Confine all returns strictly to rearing operations.

³ Including cost of 27 cross-breed capons for family use.

General Information

1. Explanation of cost items

The following items of cost may require some explanation.

Labor. In finding costs, labor must be included as a cost. If a record of the exact hours and value has not been kept, an estimate of the time required and value should be made. On the average, about 2 hours per year of man labor is required for each hen kept, and about 1 hour for each pullet reared. By the use of these figures and a certain rate per hour, the value of labor can be arrived at approximately.

On Farm 63 considerable thought had been given to saving labor; 1½ hours of man labor per average hen accomplished the work.

Table 20. Producing Eggs, Farm 63—Cost-Returns Summary

Cost			Returns		
Items ¹	No. or Lb.	Value	Items	No. or Lb.	Value
Feed			Feed bags sold	1247	\$327.02
Grain	75,300	\$3157.10	Manure sold, est.		35.00
Mash	36,600	1863.50	Stock sold, fowls	442	415.14
Other feed, gmt, etc.		101.89	Stock used	100	85.00
Labor			Misc. refund (overpaid)		5.96
Man hours @ 75 cents	1,374.6	1180.95	Patronage dividend		104.93
Auto (est. ins. and upkeep charge to hens)		83.00	Total returns		\$973.05
Taxes		140.00			
Insurance		29.10			
Fees and dues		5.00			
Water, electricity, telephone		105.00			
Miscellaneous					
Gasoline		55.00			
Delivery of feed		74.77			
Superphosphate		1.65			
Trucking		239.50			
Egg cases		235.45			
Commission		19.65			
Supplies		18.90			
Equipment		40.61			
Rodent control		43.12			
Repairs		6.39			
Disinfectant		3.48			
Interest on average investment (\$5835.75) @ 4%		233.43			
Decrease in inventory		1811.00			
Total cost of eggs		\$9527.49			

Summary	
Total cost of eggs	\$9527.49
Total returns	\$973.05
Net cost of eggs (17,602.7 dozens)	\$8554.44
Cost per dozen	\$0.486

¹ Include all items and value of items used by all old stock.

No horse labor was required. Feed was delivered by the company from whom purchased.

Taxes. An estimated \$140 was charged.

Poultry fees. Fees for associations, entry fees at fairs, etc., should be included.

Water, electricity, and telephone are important items and should be charged an estimated amount to cover a fair share of the costs.

Depreciation is shown as decrease in inventory (see Table 16).

Equipment or stock purchased. These items, being on hand at the end of the year, increase the last inventory. Because an increase in inventory acts as a return and tends to reduce the cost (decrease in inventory) just that much, it follows that the items must be included in the costs to offset it.

Miscellaneous items on Farm 63 included delivery of feed from the feed store to the plant, cartage for cases of eggs taken away from the plant, the egg cases, commissions and cartage for poultry sold and carted away, milk and other food for cats kept for rat control, and disinfectant for lice and mite control.

2. Factors affecting profits

Various factors may be found after summarizing a set of accounts, many of which may be of great importance in measuring efficiency in management and in showing where the weak or strong points are. Various factors from the records of Farm 63 may serve to illustrate.

Labor income and profits.

Labor income on poultry	\$1854.46
Labor income per hen	1.47
Profit	1482.96
Profit per hen	1.18
Eggs and poultry used by family	187.00

Farm 63 was a part-time enterprise. Two-thirds or more of the work was performed during part of each day by hired labor. Labor on the mature birds required 4.3 hours daily and $\frac{1}{2}$ hour per pullet reared for part of the year. About 5 hours daily during the rearing season was the maximum time needed for regular work on this farm. Extra help was hired when birds were moved. Had the owner done all of the work on this plant and made it a full-time job, costs of egg production or rearing would not have differed greatly, but his returns for labor or labor income would have increased considerably. Working full time and adding a few more birds would have increased still more the possibility of greater return.

Investment.

Average number of hens	1259.7
Average investment	\$7255.63
Investment per hen	\$ 5.76

The investment was average. The building was a remodeled barn containing two floors. A new wood floor was laid upstairs, and a concrete floor below. A modern water system had been installed a few years earlier. Hoppers, nests, and the like were

built by the owner. There was no unnecessary equipment. The birds were inventoried at a reasonable value at the start and at meat value at the end, except the current season's pullets, which were valued at \$2.00 each, slightly over the cost of rearing. The plant was efficiently capitalized. An effort was made to keep the investment low and to get long-time use of equipment.

Eggs, production and sales.

Total egg production, doz.	17,602.7
Production per hen	167.7
Market eggs sold, doz.	17,350.5
Eggs used, doz.	200
Unaccounted for, doz.	52.1
Cost of producing eggs, doz.	\$0.486
Average price received per doz. market eggs	\$0.566

These results show a margin of 8 cents between the cost of production and the price at which eggs were sold. The price received compared favorably with the top quotation on the New York market.

The 951 pullets at the start of the year average 179 eggs for the year. The average number of pullets was 768.5. A natural outbreak of bronchitis occurred in this flock of pullets after they had been laying 6 months and 20 days. Production dropped from 376 eggs on the 19th of November to 19 eggs on the 30th. Lights were discontinued shortly after the disease was discovered. On the 18th of December the use of lights was resumed. The production was then between 90 and 100 eggs a day. By January 13, or nearly 2 months after the disease was first discovered, the flock was back in full production. It continued fair the rest of the year (see Table 21).

Table 21. Egg Production and Number of Birds by Month, Farm 63

May 1951-April 1952

Month	No. of Birds	Monthly Production	Month	No. of Birds	Monthly Production
May 1951	951	5,731	Nov.	733	7,955
June	943	17,555	Dec.	710	2,699
July	927	17,992	Jan. 1952	694	10,182
Aug.	902	12,809	Feb.	661	12,052
Sept.	875	13,528	Mar.	635	11,847
Oct.	801	14,120	Apr.	596	10,999

Thirty-three layers died during the disease period. Shell texture was scarcely affected. For about 8 weeks the interior quality was below standard. After that time, the interior quality of the eggs produced was normal and the same premiums for quality were received by the producer as were received before the outbreak of bronchitis occurred.

If the flock had *not* been disturbed by the disease and had laid normally from November through January, the average production would probably have exceeded 200 eggs per bird.

On this farm, approximately 30 per cent of the pullets grown the year before were retained for a second year of production, which lowered the average production per bird. This reduced the cost of growing more pullets, and because of the large size of eggs laid by these yearling hens, the average price received for eggs was increased.

Approximately 52 dozen eggs were recorded on the egg record, but were not recorded in sales or use. This number of eggs unaccounted for was too high and shows carelessness. Failure to control disease and to reach better agreement on the figures for production and sale of eggs are weaknesses. Higher egg production per hen would have reduced the cost of producing the eggs.

Feed.

Pounds of grain per hen	59.8	\$2.51
Pounds of mash per hen	29.0	\$1.48
Cost of grain and mash per hen		\$3.99
Per cent of mortality, based on number of hens at beginning of year		13.7
Per cent culled, based on number of hens at beginning of year		33.3

The flock was fed by the free-choice method (page 104). Eighty-nine pounds of grain and mash were consumed per bird, in spite of the reduced consumption during part of the winter when the flock suffered from bronchitis.

The mortality was not excessive. A high food intake, resulting, no doubt, in a fine physical condition, together with careful culling may have helped in keeping the mortality low.

Altogether these results are quite satisfactory.

Pounds of grain per pullet reared	12.3
Pounds of mash per pullet reared	11.7
Cost of grain and mash per pullet reared	\$1.06

Considering that the food consumed by several capons is included, these figures are low. Mash was kept before the birds constantly during the brooding and rearing periods, and also grain after the first 6 weeks. Careful attention was given to preventing waste.

A knowledge of the existing management conditions often helps when making an analysis of a farm account. The birds were brooded and reared in confinement. They were not in contact with nor adjacent to the old birds, and were cared for by a different person. The space provided was approximately 1 square foot of floor space to 8 weeks, $1\frac{1}{2}$ square feet to 12 weeks, 2 square feet to 16 weeks, and 3 square feet per pullet after that. Automatic waterers were used. Lice and mites were controlled. Oil brooders were used, and a modern brooder house with an extra room attached. Ample window space and fan ventilation were available for use during the early winter brooding and later, as needed.

Brooding and rearing.

White Leghorns

Number of sexed pullet chicks at start	1052
Mortality	92
Percentage of mortality	8.75
Number of cockerel chicks	1
Number of pullets housed	955
Percentage of pullets housed to chicks started	90.8
Pullets used	4
Number of chicks started per pullet housed	1.1

Red Rock Cross

Number at the start	36
Number died	9
Percentage sold, used, or retained	75

These results are excellent. Good brooding and rearing and pullorum-free chicks are responsible. Reference to the brooding record (page 230) will show that all pullets were accounted for. This is more likely to happen when birds are reared in confinement than when they are reared outdoors on range.

Community Survey

1. Using forms similar to those in this chapter, secure figures from one or more farms in the community and find: (a) the labor income on poul-

try; (b) the profit on poultry; (c) the cost of producing one dozen eggs; (d) the cost of rearing a pullet.

2. Write a summary analyzing the results.

3. Write for summarized accounts to your state department of poultry husbandry at the state college of agriculture. Compare the figures with those in this chapter.

References

Botsford, H. E., *The Economics of Poultry Management*, John Wiley & Sons, New York, 1952.

Darrah, L. B., "Make Your Poultry Farm Pay," *Cornell Ext. Bull.* 713, Cornell Univ., Ithaca, N. Y., April 1917.

Diagnosing Common Diseases, Parasites, Pests, and Vices in Adult Stock

Vastly discouraging, and in the aggregate totaling an enormous loss, is the mortality that frequently occurs in both mature and young stock. This loss, if excessive, is a serious drain upon the profits of keeping poultry.

A well-reared flock of mature birds, in good health and producing well, is a source of keen satisfaction.

To find a dead bird occasionally is, to many poultrymen, nothing more than the "expected normal mortality" up to 5 or 10 per cent and of no great concern.

To discover a diseased appearance of the flock as a whole or a pronounced drop in egg production, and *then* not know the cause or the means of correcting it, is a pitiful situation. In fact, it may be a calamity to the poultry keeper.

Every person keeping poultry will do well to attempt to find out the cause of death, particularly if several birds are involved. Many diseases and troubles can be recognized at once by anyone who has given some thought and study to the subject. Other troubles are revealed only by a careful post-mortem examination of the inside of the bird's body, while still others require laboratory facilities for studying the birds bacteriologically and otherwise.

This chapter and the one following have been arranged to aid the poultry keeper in diagnosing various troubles and in determining the treatment, if known, that may be necessary for individuals or flocks, in order to keep the loss due to diseases and parasites as low as possible.

Nothing written here will take the place of the diagnosis of a trained poultry pathologist. He should be consulted and several typical birds taken to a poultry disease laboratory if the poultry-

mon has any suspicion that the trouble is pox, laryngotracheitis, respiratory, or other troublesome diseases. The poultryman should seek the advice of such help before purchasing and administering any medicines to his flock unless he is well informed of their nature, methods of use, and dangers. Furthermore, the "poultryman's diagnosis of serious diseases or troubles must be confirmed to avoid wrong interpretations with possible loss of birds and money. Write your laboratory for directions on shipping or carrying birds, and other information needed by the laboratory.

Many common diseases, parasites, and vices can be detected by amateurs who, by persistent use of diagnostic symptoms, may themselves become quite efficient. Once having made a decision, turn to the material written concerning the disease in Chapters 2 or 15 to check these findings and to learn more about it.

Caution: The symptoms given in the following pages are only guides to aid the poultry keeper. The symptoms and the disease indicated are not, in every case, exact. When used with judgment, they should be found helpful and interesting.

Examining a Live Bird

When a bird appears to be out of condition, one of the first things to do is to examine the perches and see if red mites are present. (For combating and treating the diseases and parasites mentioned in this chapter, see Chapter 15.)

Next pick up the bird and, if uncertain as to the nature of the trouble, examine the different parts of the body systematically, (see Fig. 153), referring to the following.

1. Head

There are several symptoms to look for on the head. These will be discussed in order.

Comb. (a) Symptoms: Purple blade. Frequently found but usually not serious. May indicate slow circulation at that point.

(b) Symptoms: Bluish comb and wattles. Slight limpness of comb. Sometimes accompanied by shivering of the legs, diarrhea, and sour-smelling crop contents.

Disease—Blue comb, page 266.

Comb, wattles, base of beak or face. Symptoms: Small raised water blisters, when the disease is just starting or new spots are

forming. As these blisters get older they turn hard and dark. Either type of blisters may occur alone, or both may be found together on the same individual.

Disease—Fowl pox, or chicken pox, page 268.

Eyes and nostrils. (a) Symptoms: Eyes filled with a yellow cheesy material.

Disease—Mechanical canker, page 268.

(b) Symptoms: Eyes filled with a whitish cheesy material.

Disease—Vitamin A deficiency, page 134.

(c) Symptom: Outline of pupil irregular, or bird may be blind.

Disease—Iritis, page 276.

Mouth. (a) Symptoms: The bird may gasp, and breathe with difficulty and more rapidly than usual. Breathing may be accompanied by a rattling sound or a wheezing in the throat. Coughing may be frequent.

Disease—Respiratory distress trouble, page 281.

(b) Symptoms: same as (a). Open the beak and look inside. Patches of yellowish-white cheesy growth may be found on the membranes of the sides or roof of the mouth or on the throat. Occasionally, a white growth will be seen around the opening of the windpipe.

Disease—Canker, page 268.

Fowl pox, page 268.

If no symptoms have been discovered in the various sections of the head, pass to the other parts of the body, in order.

2. Neck

Symptoms: Head hanging with neck limp or twisted.

Disease—Limberneck, page 278.

3. Crop

(a) Symptoms: Enlarged, hanging, bulging, and hard.

Disease—Cropbound, page 274.

(b) Symptoms: Enlarged, pendulous, and soft.

Disease—Inflammation of the crop (sour crop), page 275.

Enlarged crop, page 275.

4. Legs and Wings

Symptoms: Weakness or entire loss of strength in one or more. Bird may look sick about the head or may be in excellent condition at first, but loses flesh in a few days and may die.

Disease—Lymphomatosis, neural, page 278, Fig. 132.



FIG. 132. A bird suffering from a form of neural lymphomatosis.

5. Body

(a) Symptoms: Thin, emaciated. Sometimes coupled with swollen joints, causing lameness. When this condition is found, follow with a post-mortem examination.

Disease—Tuberculosis, page 282.

(b) Symptoms: Thin, emaciated; head and comb pale.

Parasite—Internal parasites, pages 286 and 287.

Disease—Coccidiosis, intestinal, page 272.

Lymphomatosis, neural, page 278.

6. Abdomen

(a) Symptoms: Hard, sometimes enlarged. This should not be confused with a very fat abdomen (Fig. 133). A fat abdomen,

although hard just beneath the skin, will usually yield to pressure, showing that it does not fill the body cavity. If a lump is felt which is more or less loose in the abdomen, or if, in pressing with the fingers, a hard body is felt, as if a baseball were inside, the trouble may be either of the following:

Disease—Tumor, page 282.

Internal layer, page 276.

(b) Symptoms: Enlarged and soft. On working with the fingers, a substance like a sac of water is felt.

Disease—Dropsy, page 274.

7. Vent

(a) Symptoms: Skin around the vent inflamed. In a more advanced stage, there may be bloody sores covered with dark scabs. A disagreeable odor is given off.

Disease—Vent gleet, page 282.



FIG. 133. A. Fat, broken-down abdomen. B. Pendulous crop. Courtesy Cornell University.



FIG. 134. Bird died, apparently owing to congestion in the abdomen. When examined, body cavity was found to be filled with these yolks and eggs. Courtesy Cornell University.

(b) Symptoms: A mass of soft, inflamed material protruding from the vent, or soiled plumage below vent.

Prolapse of the oviduct, page 281.

(c) Symptoms: Vent eaten away in part or entirely. Sometimes part of the back near the tail, or the abdomen, intestines, and part of the gizzard eaten.

Vice—Cannibalism, page 289.

8. Skin beneath the vent

Symptoms: The presence of straw-colored, elongated insects. Very often patches or clumps of grayish material will be found attached to the bases of feathers at this section. These clumps are eggs of the lice, infesting the bird's body.

Parasite—Lice, page 283, Fig. 135.

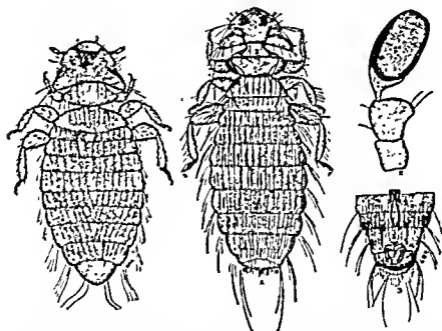


FIG. 135. Drawing (enlarged) of lice Left, the common hen louse, male. Right, the common large louse of the hen 1. Female; 2, antenna; 3, end of abdomen of male. *Cornell Univ. Bull.* 359.

9. Shanks

Symptoms: Rough, raised scales with white, powdery material beneath. This condition is known as scaly leg.

Parasite—Scaly leg mite, page 288.

10. Feet

Symptoms: Bottoms of feet swollen. In a more advanced stage, the swelling may be inflamed, pushing out between the toes and causing lameness. (See Figs. 136 and 137.)

Bumble foot, page 268.



FIG. 136. Bumble foot. Note the swelling between the toes of the foot on the left.



FIG. 137. Bumble foot. Note the hard circular scab in the bottom of the left foot. Both feet are swollen, hot, and painful.

Examining a Dead Bird

See Chapter 23 for anatomy of the domestic fowl.

1. External examination

When a bird dies, examine her comb and head first. If they are dark purple in color the trouble is likely to be

Apoplexy, page 265.

Symptoms: Birds in good physical condition, showing no evidence of disease or vermin, found dead on the nest or about the buildings during very warm weather.

Heat prostration, page 275.

Internal hemorrhage, page 275.

If neither of these troubles appears to be the cause of death, examine the bird externally for disease and troubles mentioned in the preceding section.

2. Internal examination

In case the trouble cannot be diagnosed by a superficial examination or the bird has been killed because of a supposed disease, a post-mortem examination of the internal organs should be made to determine the cause.

Materials needed. A few materials, together with a knowledge of what to do and what to look for, are needed. These are:

(1) A wooden surface about 2 feet square, such as a board or the side of a box, about waist high.

(2) A sharp knife.

(3) A pair of heavy shears for cutting through bones (pruning or tin shears or any shears having a narrow blade on one side, for pushing between the bones and internal organs).

Arranging the bird. (Fig. 138.) Place the bird on its back, head away from the operator. Stretch the wings out. Cut the skin between the legs and body, bend the legs back, dislocating the joints at the hips.

Opening the carcass. With the shears lay open the esophagus from the corner of the mouth to the crop. Look for cankerous growths inside the mouth and around the windpipe.

3. Trachea, larynx, or bronchi

Slit the windpipe or trachea and the bronchi.

(a) Symptoms: Presence of bloody mucus.

Disease—Laryngotracheitis, Infectious, page 276.

(b) Symptoms: Moldy patches of a white or greenish yellow color, on the inside of the trachea. They may occasionally be found in the lungs and air sacs.

Disease—Aspergillosis, page 266.

(a) Symptoms: Whitish mucus.

Disease—Chronic respiratory disease, page 272.

4. Esophagus

Symptoms: Numerous small whitish nodules on the inside lining.

Vitamin A deficiency, page 134.



(1)



(2)

FIG. 133. Preparing a hen for internal examination. (1) First step is to remove the skin from the breast. Follow by cutting the skin to the mouth and to the vent, and laying it back to expose the flesh. (2) Organs exposed: *A*, windpipe or trachea; *B*, esophagus; *C*, crop; *D*, bronchi; *E*, intestines; *F*, ovary; *G*, oviduct; *H*, liver; *I*, thigh; *J*, breastbone.

5. Breast

With the knife, cut through the skin, across the abdomen. Grasping the skin near the vent, tear it loose from the breast by pulling up and toward the head.

Examine the breast, which should now be exposed. If it is found emaciated, then tuberculosis, worms, or lymphomatosis may be the cause.

If small, hard, yellow bodies are found attached to the underside of the skin over the muscle, they are due to encysted parasites. These parasites have no harmful effect on the fowl and do not affect the edibility of the flesh.

Using the knife, cut through the flesh of the abdomen. Do not cut deeply.

With the shears, cut through the ribs to the neck near the base of the wing. Fold the breast back and remove.

(a) Symptoms: Clotted or fluid blood among the intestines and particularly in the region of the heart. Likely to be accompanied by a comb from which the blood appears to have been drawn.

Internal hemorrhage, page 275.

(b) Symptoms. Fine, yellow, dustlike particles. If found, examine between the ribs and internal organs, without displacing them, for the same particles. They may be found on the lungs or along the side of the body, where they are left after the rupture of the air sacs.

Parasite—Air-sac mites, page 283.

6. Liver and spleen

(a) Symptoms: Presence of raised, white, hard, cheesy nodules, easily removed from the tissue with a pair of tweezers.

Disease—Tuberculosis, page 282.

(b) Symptoms: Liver appears greatly enlarged, grayish, and spongy.

Disease—Lymphomatosis, visceral, page 279.

7. Heart

Fold the liver back or remove in order that the heart may be seen.

(a) Symptoms: Clot of blood near the heart.

Internal hemorrhage, page 275.

(b) Symptoms: Sac (pericardial) about the heart enlarged and filled with a chocolate-colored pus. Pericardium may be attached to the heart by strings of tissue.

Disease—**Pullorum disease**, page 32.

8. Intestines

With the fingers loosen the heart, liver, and intestines. Remove these organs and arrange upon a board.

(a) Symptoms: Nodules of various sizes attached to the intestinal wall. Occasionally several nodules and walls seem to be grown together. Cut a nodule. Open cavities are usually found which open into the intestine.

Disease—**Tuberculosis**, page 282.

(b) Symptoms: Clumps in the intestine. Whether found or not, cut the intestine lengthwise at intervals and examine for elongated white worms. (See Fig. 139.)

Parasite—**Roundworm**, page 286.

(c) Symptoms: Segmented white worms attached at the small end to the intestinal wall. Length, 1 to 3 inches; sometimes 6 to 10 inches.

Parasite—**Tapeworm**, page 288.

(d) Symptoms: Thickened wall in the fore part of the small intestine. May be inflamed. Microscopic examination necessary for accurate diagnosis.

Parasite—**Tapeworm (microscopic)**, page 288.

Disease—**Coccidiosis, intestinal**, page 272.

9. Ovaries

Symptoms: Hardened, irregular bodies, mingled with the normal ovules. The color may be mottled, light, dark, or occasionally so dark and of such a color as to appear like gangrene. (See Fig. 140.)

Disease—**Pullorum disease**, page 32.



FIG. 139. The roundworm (enlarged).



FIG. 140. Pullorum disease or bacillary white diarrhea. Infected ovary. From University of Connecticut.



FIG. 141. Normal ovary. From University of Connecticut.

10. Oviduct

Symptoms: Enlarged throughout several inches of its length. Upon opening, a mass of coagulated white material (albumen) is found.

Impaction of the oviduct, page 275.

11. Abdomen

(a) Symptoms: Free water in the body cavity (that part of the body which contains the intestines and internal organs).

Disease—Dropsy, page 274.

(b) Symptoms: Hardened lump, which when cut shows a solid mass of yellowish material.

Internal layer, page 276

(c) Symptoms: Complete or partly complete eggs outside of the oviduct and free in the body cavity. (Fig. 134.)

Internal layer, page 276, Fig. 134.

Vices

1. Egg eating

Symptoms: Evidences of broken eggs found in the nests; the beaks and heads of birds smeared with egg yolk. (See page 291.)

2. Cannibalism

Symptoms: Birds bloody and partly eaten about the head or back.

During periods of heavy production, birds may be found dead, with vents, intestines, and sometimes their internal organs, eaten away. (See page 289.)

Treating Diseases and Combating Parasites, Pests, and Vices

When one has determined the trouble by his own diagnosis or that of a poultry pathologist, the next step is to know how to combat it. Proper *management practices*, as emphasized throughout this edition, are vastly important and will go far toward eliminating many of the troubles, pests, and diseases discussed in this chapter.

Individual handling and application are sometimes necessary, as when vaccinating. Research workers are constantly seeking new and improved methods of control for specific diseases, and better methods of application, especially mass treatment.

Chemotherapy is used in poultry disease control. This consists of the treatment of internal disease by chemical reagents that have a specific and toxic effect upon the microorganism that causes the disease, without seriously poisoning the bird.

Medicinal ingredients in the mash. For treatment of several diseases, certain medicinal ingredients to be included in the regular mash feed have been recommended. *Continuous feeding of medicated mash is seldom recommended* except in broiler growing. To do so increases the cost of feeding, may result in lack of watchfulness on the part of the feeder, and may allow other diseases to gain and keep a foothold.

Dangers in continuous use of a medicated feed are: * (a) There is a tendency to think of feed as a vehicle for the drug mix rather than to think first of its nutritive purposes; (b) the danger of wrong diagnosis may result in recommending the wrong treatment; (c) because the small amount of certain medicants required makes

* Summarized from "Use and Abuse of Medicants in the Feed," P. P. Levine, New York State Vet. Coll., Cornell Univ., in *World's Poultry Sci. J.*, April-June 1954 page 171

it difficult to secure proper mixing in some cases, death or subacute intoxication have occurred, and in some instances this trouble has not always been recognized; (d) some medicants mixed in feeds are incompatible with certain nutrients in the feed or with other medicants (para-amino-benzoic acid, which is advocated in some quarters for handling chronic respiratory disease, is directly antagonistic to the action of sulfonamides commonly used for coccidiosis control); (e) medication may cause the feed to be unpalatable.

Medicants in the feed are not a substitute for food nutrients and proper management. They are a temporary expedient. Poor management may be responsible for the trouble. If it is, it should be corrected.

General information (cause and treatment):

Apoplexy	Laryngotracheitis, infectious
Aspergillosis	Leucosis complex
Blue comb	Lumberneck
Bronchitis, infectious	Lymphomatosis, neural
Bumble foot	Lymphomatosis, visceral (big liver)
Canker	Newcastle disease
Canker, mechanical	Prolapse of oviduct
Chicken or fowl pox	Respiratory distress troubles
Cholera	Tuberculosis
Chronic respiratory disease	Tumors
Coccidiosis, intestinal	Vent gleet
Coryza, infectious	Air-sac mites
Cropbound	Lice
Dropsy	Red mites
Enlarged crop	Roundworms
Heat prostration	Scaly leg mite
Impaction of oviduct	Tapeworms
Inflammation of the crop (sour crop)	Cannibalism
Internal hemorrhage	Egg eating
Internal layer	Pickout
Iritis	

Apoplexy

Cause: A ruptured blood vessel, which allows a clot of blood to press on the brain. Any unusual exertion, such as the strain of laying, or sudden fright may cause apoplexy.

This is not a disease that will spread from bird to bird.

Treatment: Practically none for the individual, as the bird is usually dead when first observed.

Aspergillosis

Cause: Certain molds and their spores that occur on moldy, musty, and spoiled litter or feed. These molds work into the air passages and grow, penetrating the tissues and causing inflammation of these passages, resulting in death in some cases.

Prevention: Consists mainly in providing only clean, wholesome feed and litter. Musty or moldy litter or feed should be avoided. Litter which has been wet and allowed to mold should not be used. Clean, dry houses will do much to prevent these molds from starting.

Remove affected birds, bury any that die, and correct the conditions.

Blue comb

Cause: May be a virus. More commonly affects pullets but may attack hens or males. More likely to occur in late summer or early fall in the North and during warm, humid weather, but may occur in the winter months. It is considered one of the most common and serious troubles. Heavy mortality is frequent. Birds cease eating but drink readily.

Treatment: Potassium has a protective action on the kidneys. These organs are dangerously affected. Potassium may be given in the form of muriate of potash.

Muriate of potash—1 tablespoonful per gallon of drinking water for 4 days. For the next 10 to 14 days, mix $1\frac{1}{2}$ pounds to 100 pounds of mash.

Antibiotics: As this edition goes to press, terramycin and aureomycin are thought to be beneficial when mixed with mash at the rate of 100 to 200 grams of the antibiotic per ton of mash and fed for several days.

Bronchitis, infectious

This disease is similar in its symptoms to Newcastle and other respiratory troubles. Sneezing and coughing prevail. It spreads rapidly from bird to bird in a flock, and to all flocks on the same farm or others in the neighborhood. Within a few days after symptoms are observed, production may drop to a low point, then slowly start to recover, and reasonable production (rarely over 50 per cent) may be reached in about 8 weeks from the time the disease was first noticed.

The usual recommendation has been to dispose of the flock soon after the disease is noticed. However, since this procedure eliminates all returns from eggs and production will be resumed if the flock is held, certain producers may wish to retain the flock. Cost of holding will be partially reduced by the eggs the flock continues to lay. Both exterior and interior egg quality are lowered for several weeks because the disease has an adverse effect on the egg-production organs.*

It is suggested that lights be discontinued when the disease is discovered and for a period of 3 to 7 weeks, then resumed. Full feeding and proper management should be continued. It is recognized that a check in production is likely to throw laying hens into a molt; therefore, the shock of disease plus removal of lights may result in molt. During this 2-months' rest period, many eggs will be laid, the egg-forming tissues are allowed to recover without stimulus from light, and the molt is nearly completed. In a practical case the results were fairly rewarding, but this experience has not yet been substantiated by careful research data.

Cause: A virus.

Prevention is best. By a method developed in Massachusetts by Dr. H. Van Roekel and now in use elsewhere, 1 per cent of the chicks 8 to 16 weeks old (preferably 10 to 14 weeks) are given the disease by the use of a live virus mixture administered by a qualified veterinarian, and then released in the entire flock of chicks. Within 1 to 6 days all are infected and pass through a form of the disease. Five weeks after, the birds are immune for life and are not carriers. The symptoms usually disappear in 10 to 12 days.† In cold weather, the quarters should be kept slightly warmer than usual.

Because of the virulence of the disease, it is customary in many places to require 75 per cent of the poultrymen of an area to vote favorably for the service before the laboratory or poultry disease officials will extend it. In some cases, poultrymen who want their birds immunized may take 1 per cent of the flock to the laboratory or meet at some central point for the immunizing work.

The effectiveness of bronchitis vaccine has not been established.

* S. Gordeuk, Jr., and G. O. Bressler, "Infectious Bronchitis, Its Effect on Rate of Egg Production and Egg Quality," *Progress Report* 36, Pennsylvania State Coll., State College, Pa., 1950.

† H. Van Roekel, M. K. Clarke, K. L. Bullis, O. M. Olesink, and F. G. Sterling, "Infectious Bronchitis," *Am. J. Vet. Research*, April 1951.

Bumble-foot

Cause: Bumble foot is probably due to a bruise which develops beneath the skin. Small stones, gravel floors, high perches requiring the birds to jump to hard floors, and, more commonly, an insufficient amount of litter on the floors may be causes.

Bumble foot is an abscess which forms on the bottom of the foot and may spread between the toes and sometimes up the leg (Figs. 136 and 137).

This trouble does not spread from one individual to another. Use the bird, if in good condition, or treat if it is desired to keep it.

Treatment: Somewhere, usually on the bottom of the foot, a round, hardened scab about $\frac{1}{8}$ inch in diameter or larger will be seen. Pull this out with the fingernails, a knife, or tweezers. A long core is usually attached to the scab and comes out of the opening, leaving a hole. Disinfect the wound with iodine and fill the hole with Carbulated Vaseline.

If the swelling spreads out between the toes, make an incision at the top and clean out all pus before disinfecting.

The bird may be released with the flock in mild cases; in advanced cases, the foot may be bandaged and the bird placed by itself for 2 to 3 days.

Canker (chicken or fowl pox)

Cause: Same as for chicken pox. This is usually accompanied by chicken pox, a nasal discharge, and perhaps a swelling of the face in severe cases. It spreads by contact or through the drinking water.

Treatment: See chicken pox.

Canker, mechanical

Cause: A foreign body in the eye or other part. Irritation is started, and a white cheesy material forms about the object. There is no running at the nose.

Treatment: With a toothpick, remove the mass. The foreign material will be found in it. The bird may be released without further treatment.

Chicken or fowl pox

Cause: A virus which spreads rapidly from one infected flock to another on crates, bags, and clothing, or from bird to bird by

direct contact, bloodsucking insects, drinking water, and feed. Mosquitoes having once fed on a diseased bird may carry the virus to well birds for 27 to 30 days afterward. It may spread rapidly or slowly in a flock or neighborhood. Occasionally a few birds in a flock will be affected and upon their removal the spread may be checked completely. However, the risk of reinfection is considerable once the disease has appeared, and vaccination for a few years is advised.

Fowl pox is a contagious disease. In the early stages, watery raised blisters are apparent, sometimes accompanied by a foamy discharge from the eyes. Later these blisters change to dark scabs. This is called the *dry form*. Cheesy patches may occur in the mouth or throat, and the opening into the windpipe (larynx) may become plugged. This is known as the *wet form* of fowl pox.

In serious cases there is a drop in production and a decrease in the amount of feed eaten, the birds appear droopy, and diarrhea is often present. If the scabs locate on the eyelids, the eyes soon close.

The disease is most severe in late fall or early winter, although it may break out at various times during the year. Young chicks are occasionally attacked by fowl pox.

Treatment: If the disease breaks out in a *laying flock*, vaccinate immediately with pigeon-pox vaccine applied by the feather-follicle method. This will check the spread of the disease with less production loss than if chicken-pox vaccine is used. Even though a natural outbreak does not occur in a laying flock, but the disease appears on an adjoining farm or in the immediate vicinity, it would be well to vaccinate these birds with pigeon-pox vaccine in order to protect them.

Pigeon-pox vaccine produces a temporary type of immunity (protection). It will protect the birds for perhaps 3 to 4 months. It may become necessary to revaccinate, depending upon the length of time the birds are to be kept.

Caution: Secure a *reliable vaccine* from a poultry disease laboratory or commercial companies which have been licensed by the U. S. Department of Agriculture. *Administer* the vaccine according to the directions of the manufacturer. Directions usually given appear below.

The feather-follicle method. Remove three or four feathers covering about 1 square inch of skin on the lower thigh. Apply vac-

cine to the skin follicles with a short stiff-bristled brush supplied with the vaccine.

Vaccination of growing pullets to prevent an outbreak of chicken pox is advisable if the disease has appeared in the vicinity or in the home flock. Use chicken-pox vaccine for this.

Range pullets 3 to 4 months old may be vaccinated by the *needle or wing-web method*. Fasten one sewing machine needle in the end of a wooden handle. Dip the eye end into the vaccine



FIG. 142. Vaccinating for chicken pox by puncturing the web of the wing.

and then plunge it through the web of the wing, avoiding large blood vessels and feathers. When the needle is withdrawn, vaccine is left on one place above and one below the web. This method is more rapid than the feather-follicle method. (Two needles were used in the past to more adequately ensure a "take." Sets for this work are available at poultry supply houses.)

There can be little loss in egg production, as the birds recover completely from the vaccination before they reach maturity and commence to lay. Vaccination does retard growth and reproductive development from 3 to 4 weeks, but there is satisfaction in knowing that the disease need not be feared the following fall and winter. Vaccination renders the birds immune.

Birds suffering from *coccidiosis*, internal parasites, or other ailments are affected more severely by vaccination than healthy and vigorous birds. Because they have less resistance, considerable mortality may occur.

Cholera

The organism causing fowl cholera lives only a short time outside the body of affected birds. The organism may be present in the nasal chambers of birds that show no symptoms of disease. These carriers and the diseased birds are the sources of outbreaks.

Outbreaks of cholera, in many instances, appear to depend principally upon bad hygienic conditions. That is to say, outbreaks may occur when birds are overcrowded, in dirty quarters, and in poorly ventilated quarters, even though infection has not been introduced from outside. Outbreaks may also occur under good sanitary conditions, but usually a virulent infection has been brought in from outside through the introduction of diseased birds. Chickens, ducks, pigeons, turkeys, and caged birds may be affected.

Nature of disease: Fowl cholera has two forms. In one the birds die suddenly without significant symptoms. In this type the germ enters the blood stream and quickly kills the bird. Post-mortem examination reveals small white areas on the liver, hemorrhages on the heart and other organs, and mucoid and bloody intestinal contents.

The other type is chronic and produces respiratory symptoms. Affected birds do not die suddenly, and many may recover. The mortality may be large, particularly when complications are present, and the disease spreads rapidly through the flock. A post-mortem examination reveals pus in the nasal chambers and sometimes in the air sacs.

Symptoms: The first form of the disease produces a general depression. When the birds die suddenly, symptoms are not often observed.

The second form begins with "colds." This is accompanied by gasping and by a swelling of the head and wattles. Symptoms of infectious bronchitis must be differentiated from those of this type of fowl cholera. The wattles when first swollen are soft and warm; later they become hard and cold. When the outbreak has subsided, a number of thin birds will be found in the flock. The air sacs in these birds contain pus, which prevents the birds from making a complete recovery.*

Treatment and Control: Those who wish to retain the flock for as many eggs as possible may feed *terramycin* at the rate of 300 grams per ton of feed and cull vigorously.

Sulfaquinoxaline, 0.05 per cent to 0.01 per cent in drinking water, has been recommended to stop the ravages of the disease, but relapses usually occur when medication is withdrawn.

Sulfamethazine, 0.05 per cent in the mash or 0.01 per cent in the drinking water, has also been suggested. However, since an apparently recovered flock is never entirely so and carriers continue indefinitely, the usual recommendation is to dispose of the flock, allow a few weeks to elapse, and start new.

*From *Cornell Ext. Bull.* 337.

Chronic respiratory disease (C.R.D.), or air-sac infection

Much uncertainty concerning causes, mode of transmission, and treatment of this disease exists as this edition goes to press. The disease (C.R.D.) was first described by Deleplane and Stuart of the Rhode Island Station in 1913. Later, Johnson of the Virginia Station reported that, chiefly among broiler chicks, a respiratory disease occurred with symptoms such as slight nasal discharge, persistent hacking cough, reduced feed consumption, retarded growth, and 10 to 20 per cent mortality.

The disease may remain for a very long time in a flock, perhaps an entire laying season.* Air-sac walls are thickened and covered with yellow cheesy material, and pus accumulates in the air-sac cavities. The windpipe may contain whitish mucus. The disease often appears in flocks that have been immunized against Newcastle and infectious bronchitis.

Economic importance. Reports are prevalent that poultry carcasses showing caseated material have been condemned in market channels. Unprofitable egg production may be due to the effects of the disease.

Cause: A pleuropneumonia-like organism which is transmitted through the egg.

Treatment: No practical treatment for C.R.D. has been discovered. Streptomycin, aureomycin, chloromycetin, and terramycin appear to exert an inhibitory effect on secondary bacterial invaders when fed at the rate of 200 grains per ton of feed.†

Effort by poultrymen and especially broiler men to supply management conditions that will aid the birds in minimizing the unfavorable conditions of medication, hormonizing, vaccination, and competition for food, water, air, and other necessities for growth should aid in the battle against C.R.D.

Coccidiosis, intestinal

(Acute coccidiosis is discussed on pages 28 to 30.)

This disease may appear in stock 3 or 4 months of age or any time during the first laying year. Egg production is decreased. An infestation of worms may produce similar symptoms.

* J. Fabricant, "Chronic Respiratory Disease," *World's Poultry Sci. J.*, October-December 1952, p. 294.

† H. Van Roekel, O. M. Olesank, and H. A. Peck, "Chronic Respiratory Disease of Chickens," *Am J Vet. Research*, April 1952.

Cause: The disease is most often caused by the organism *Eimeria necatrix*, though there are other intestinal forms. Some of these are: *E. tennello*, caecal or acute type; *E. maxima*, damages the small intestine; *E. brunetti*, ulcerates and sloughs off the intestinal lining in old and young stock; *E. ocervulina*, produces white streaks across the lining of the upper intestine of older birds; *E. mitis*, causes diarrhea; *E. praecox* and *E. hogani*, do little damage.

Most birds have the ability to withstand a few coccidia in the intestinal tract. When great numbers are swallowed, their combined forces overcome the bird's natural resistance. It appears, then, that one method of control is to limit the numbers that birds are likely to get.

Treatment: The best treatment is prevention. Practice precautions similar to those for acute coccidiosis. Range houses at proper distances, uncrowded confinement rearing, and separation of young and adult birds during rearing are important. However, when an outbreak occurs, sulfaquinoxaline is recommended, at the rate of 0.05 to 0.1 per cent in the mash, fed continuously for 4 days. This drug is more quickly available through the intestinal wall and into the blood stream than are those previously used.

Coryza, infectious

This disease may occur in a mild form with a nasal discharge as the only symptom (simple coryza), or it may include swelling of the face and wattles, or infection in the respiratory tract. In the severe form, coughing, gaspiog, and sneezing may result.

The disease may last for different lengths of time. Often it spreads slowly from bird to bird in a flock with the result that production, although greatly reduced, is never zero in the flock as a whole. This loss in egg production in a laying flock may be severe and may make the disease very important economically. Mortality may be considerable.

Cause: Coryza is caused by the organism *Hemophilus gallinarum* and may be distinguished by isolating this organism. A laboratory examination is therefore necessary for positive identification.

Birds which have recovered from the disease act as carriers. Direct contact must be prevented between old birds and the young stock. If the old flock can be disposed of a few days before young stock is to occupy their quarters and the place cleaned, there is little likelihood of transmitting the disease. This applies regardless of whether the birds were on new, built-up, or compost litter.

The organism is apparently short-lived outside the carrier's body.*

Treatment: $\frac{1}{2}$ per cent sulfathiazole in mash, fed 3 to 5 days.

At one time very troublesome, coryza is rarely seen today.

Cropbound

Cause: Some coarse material, such as straw, dried grass, etc., becomes impacted in the crop and blocks the passage.

Treatment: In most cases, dispose of the bird. If individual treatment seems desirable, the mass should be removed from the crop. To do this, moisten the skin over the crop with a 5 per cent solution of carbolic acid in water. With a sharp knife, make a slit in the skin about 1 inch long, over the center and upper part of the crop. Move the slit skin to one side and make a cut in the crop, so that when the skin is released the two cuts will not be directly in line. With the fingers, tweezers, or a blunt stick, gently remove the material through the cuts. Clean out the crop with warm water. With a needle and thread, take three or four stitches in the crop, and also the same number in the outside skin. Disinfect the part. Give a little water, and after a few hours some moist mash. In a day or two the bird may be placed with the flock.

Dropsy

Fluid collects in the body cavity and may enlarge the abdomen, hence the often-used term "water belly." This condition is quite often found in birds after their first laying year.

Cause: A slight disorder of the lining of the body cavity. "No one specific causative agent is responsible. The accumulation of fluid results from a filtration of blood serum through the serous membranes of the intestine, or the peritoneal covering of the abdominal cavity. . . . It may be present in . . . debilitating diseases affecting the abdominal organs." †

Treatment: It is best to dispose of the bird.

* J. R. Beach and O. W. Schalm in *Poultry Sci.*, Vol. 15, No. 6, 1936, report a series of experiments, in one of which an artificially infected bird was caged for 3 weeks, killed, the exudates removed from the head, suspended in a salt solution, and poured over the litter and mixed with the feed and water. Ten birds were placed immediately in the cages thus treated, 9 others after a lapse of 24 hours, and 4 after a lapse of 4 days. They were left in for periods of 5 to 7 weeks. Only 4 of the 10 placed in the cages immediately contracted the disease. All the remaining birds were proved later to be susceptible.

† Ward and Gallagher, *Diseases of Domestic Birds*.

Enlarged or pendulous crop

Cause: A condition due to general weakening of the crop muscles. It is thought to be inherited in turkeys. It may be associated with either cropbound or sour crop troubles, in chickens.

Treatment: The bird will usually remain productive unless the crop is so large as to be in the way while eating. Generally, the best plan is to kill and bury the bird when she ceases to lay.

Heat prostration

Heat frequently causes the death of birds in nests or in buildings during extremely warm weather. The evaporation of moisture is a cooling process. On very warm days (over 90 degrees F.), sprinkling the walls and roof inside and out has helped lower the temperature. In areas where the birds are kept in laying cages, lives have been saved during rare periods of intense heat by spraying the birds themselves until water drips from the feathers, whereas many died under every other method of cooling by water.

Impaction of the oviduct

Cause: An accumulation of broken egg yolk and albumen material, resulting from inflammation and stimulation of the oviduct glands, which hardens in the oviduct and may later decompose.

Treatment: There is no satisfactory treatment.

Inflammation of the crop (sour crop or thrush)

A disease caused by fungi, which may cause small, slightly raised, whitish nodules on the inside crop lining. It may occur in young or old birds, but is likely to be more serious in chicks. The crop contents become very sour.

Treatment: If detected early, give one level teaspoonful of powdered bluestone (copper sulfate) to each 2 gallons of water, every other day for a week.* In advanced cases kill the bird.

Internal hemorrhage

Cause: The cause may be the same as that of apoplexy. Rough handling of the bird, tumorous growths, or undue strain may cause a rupture of the blood vessels near the heart or elsewhere.

* E. Jungherr, "Diseases of Brooder Chicks," *Bull.* 202, Univ. Connecticut, Storrs Agr. Exp. Sta.

Internal layer

Cause: This may be due to a ruptured oviduct or to the incomplete functioning of the oviduct at the time when the ovule breaks loose from the ovary (page 424). In the latter case, the funnel-shaped opening of the oviduct does not pick up the ovule, and it rests in the body cavity. A large ball of seemingly cooked yolks may result. Infectious bronchitis may be responsible.

Occasionally, reverse peristaltic action of the oviduct takes place, forcing the complete egg from the uterus at the end of the oviduct back and out of the funnel-shaped opening, into the body cavity. Hens have been opened and found to have several completed eggs floating free within the body. (Fig. 134).

Treatment: None. It is better to use the bird.

Iritis

Iritis is thought by some to be a separate entity of the leucosis complex. It occurs when the iris of the eye becomes diseased. The pupil itself appears irregular or may be nearly or completely covered by the iris, causing blindness. Regardless of color, an irregular iris that is unresponsive to light is ordinarily associated with leucosis and blindness. Formerly, the *gray eye* was regarded as an undesirable feature associated with leucosis. However, the actual color may not be a symptom. (See page 301.)

Occurrence of iritis is low in experimental work, and it is found rarely in the field.

Cause: Unknown, but probably a virus.

Laryngotracheitis, infectious

Cause: A filterable virus which finds its way into the eyes, nostrils, or the windpipe. The disease is not in the blood, hence is not spread by bloodsucking insects. It may spread very rapidly, reach the peak in 7 to 8 days, then subside and disappear in 14 to 21 days. Mucus and clotted blood obstruct the air passages, and if this is not coughed up, the bird may strangle. Death is due entirely to suffocation. The coughing and gasping may be accompanied by a rattling of the mucus in the windpipe.

Birds recovering may be immune but become carriers of the disease and may transmit it to others. Once introduced, it is carried over from year to year by the bird "carriers" in the flock.

The virus must first come to a farm from some outside source,

through purchased stock or birds from laying tests or shows, visitors, crates, bags, or other transferable equipment. The virus does not spread on the shell of eggs except under unusual laboratory conditions.

Treatment: Prevention is best. Use caution when introducing adult stock to the plant.

If the disease is discovered, its spread may be prevented by vaccinating all unaffected birds. An *accurate diagnosis is necessary* before vaccinating because the vaccine will not protect against other diseases that look like laryngotracheitis. Either vaccinate or dispose of all birds.

When pullets are to be kept on a farm where there are carriers present, the chicks should be vaccinated when about 6 weeks old. This produces an immunity.

When these precautions are taken, the disease after a few years may cease to be troublesome.

Vaccination: E. L. Brunett has discussed vaccination thus: *

The vaccine is applied to the bursa of Fabricii, which is on the upper side of the vent. The bird is held by an assistant, and the upper part of the vent is rolled open with the thumb and the forefinger. A stiff brush moistened with the vaccine is inserted into the bursa and is brushed back and forth several times. Some prefer to place the vaccine in the bursa with a syringe. Some practice is necessary before one can become proficient with either method. Five days after vaccination, a swelling of the upper part of the vent should be evident. This indicates a "take." Birds not showing this "take" should be revaccinated. It is rather difficult to get 100 per cent "takes" in one vaccination.

Note: The virus does not persist in the cloaca longer than 10 days after vaccinating. Hence, such vaccinated birds will not spread the disease to other birds on the same or other farms after that time.

Leucosis complex

Among the most baffling types of diseases or groups of diseases are those considered under this general term. Accumulated data indicate that a few at least of the diseases thought to be members of the complex may be separate entities. It has been suggested that conclusions reached by different investigators, working, as was supposed, on certain different expressions of the same disease and arriving at different interpretations, can be valid if the as-

* *Poultry Diseases*, Cornell Ext. Bul. 337.

sumption is made that members of the complex have different causative agents.

Studies of many years of results "justify the belief that the four types of lymphomatosis, i.e., visceral, neural, ocular, and osteopetrotic, represent four distinct disease entities, and are caused by four distinct and different agents." * See lymphomatosis, neural and visceral.

Limberneck

Cause: A paralytic condition resulting from the eating of toxins present in decaying meat and spoiled food. Flies or maggots feeding on such material take these toxins into their bodies. Fowls eating such flies or maggots may show symptoms of the disease.

Treatment: It is usually best to bury the carcass. Eliminate the cause.

Lymphomatosis, neural

This is a nerve disease and may attack nerves in various parts of the body, sometimes but not always causing birds to lose control of wings and legs. The bird may still be laying and a picture of health even after paralysis sets in. This form is most easily seen when expressed as paralysis. At first, one or both legs appear to be handled awkwardly, later becoming useless and extending full length in front or in back of the body as the bird rests. One or both wings may hang down. A bird may give the appearance of walking on tiptoes or stiff legged. This is sometimes noticed during the rearing period. It is well to remove such birds.

The disease was formerly known as *range paralysis*. It is more commonly found during the latter part of the rearing period and early months of the pullet laying year, and appears somewhat earlier than does the visceral type.

Nerves may be affected which lead to various parts of the digestive system, paralyzing it and resulting in extreme emaciation and death.

Cause: Unknown, but *may* be a virus. Spread by contact, it is apparently *not* transmitted through the egg.

Treatment: There is no known cure. Isolation rearing to 5 months or more appears the most practical. Infection probably

* N. F. Walters, "Etiological Relationship of Visceral and Neural Lymphomatosis," *Poultry Sci.*, March 1954, p. 365.

occurs early in the chick's life, but susceptibility is largely overcome by 5 months. Proximity to older birds, or clothes, feces, and the like, which have been recently in contact are means of transmittal to chicks.

It has been demonstrated that breeding for strain resistance to neural lymphomatosis can be accomplished. Breeders and hatcherymen should practice this. It is a long-time procedure. Natural selection appears helpful, especially where birds past the pullet year are used as breeders. The practical poultry keeper can do little but take advantage of such work, purchase chicks from hen breeders if troubled with the disease, practice isolation rearing, and dispose of diseased birds when noticed.

Lymphomatosis, visceral (big liver)

Tumor tissue is diffused through the liver or other organs, leaving them enlarged and with a puffed-up, grayish, spongy, roughened surface. The borders are round and rupture easily. Birds often bleed internally, death resulting.

The infections are established weeks or months before the birds show evidence of the disease. During this time the comb and wattles appear normal and laying may occur. Near the end the bird appears weak, unsteady, and pale about the head.

Prevalence varies in different parts of the country.

Cause: A virus. Evidence is strong that this type is transmitted through the egg, by way of the incubator, and by contact with adult birds. Apparently healthy birds may harbor the disease and infect their offspring.

Treatment: Prevention consists of isolation rearing or avoiding contact with older birds, at least until 5 months of age. Infection may occur early in the chick's life. Follow recommendations given under the *neural* type.

Watch the adult birds and dispose of suspicious birds as noticed. The trouble may decrease or even disappear on a particular farm over the years. In the meantime, live with it.

Newcastle disease

A relatively new disease, introduced in 1941 from Asia by way of England to the West Coast, where it was and still is called avian pneumoencephalitis. In 1945 it appeared in New Jersey, and later throughout the Northeast.

Symptoms—Young chicks: The onset of the disease is sudden and it spreads rapidly. A respiratory infection similar to bronchitis occurs. The chicks cough, sneeze, and may have a slight nasal discharge. Mortality is heavy and may reach as high as 90 per cent. Nervous symptoms, in the form of twisted heads and necks and partial or complete paralysis, may occur up to about 5 per cent of the affected birds. These reactions may occur at the same time as the respiratory symptoms or after they have subsided.

Immunity: Chicks hatched from immunized parents have been supposed to be immune for several weeks. However, natural outbreaks have occurred in such chicks at 2 weeks of age. Infections following intranasal or intramuscular inoculation have also occurred. The mortality in these chicks was greatest among chicks having intramuscular inoculation.*

Studies of killed- versus live-virus vaccine indicated that chickens inoculated with a single dose of killed-virus vaccine, introduced intramuscularly, were susceptible 3 to 4 weeks later. Although little mortality occurred, "... every chicken exposed by intranasal inoculation, direct contact exposure, or airborne contact exposure acquired infection of the respiratory tract."* Elsewhere, experiments have shown chicks vaccinated with killed-virus vaccine at day old or older contracted the disease after reaching sexual maturity, suffering a severe drop in egg production. The choice of killed or live virus may rest with the intended use of the birds, whether for broilers or for layers. Consult the state poultry disease specialist for recommendations.

Symptoms—adult birds: Respiratory symptoms occur, similar to those seen in chicks. Relatively few old birds, if any, become affected with nervous symptoms. Mortality is negligible. Egg production drops rapidly, and in about a week ceases almost entirely. The birds recover and eventually come back into full production. For several weeks after recovery, eggs may have abnormal shells, many air cells loose and bubbly, and weak albumen.†

Cause: Virus.

* E. R. Doll, W. H. McCollum, and M. E. Wallace, "Susceptibility to Newcastle Disease Infection of Chickens from Hens Immunized with Live Virus Vaccines," *Am. J. Vet. Research*, July 1951; E. R. Doll, M. E. Wallace, and W. H. McCollum, "Susceptibility to Newcastle Disease Infection of Chickens Vaccinated with a Killed Virus Vaccine," *Am. J. Vet. Research*, October 1951.

† J. R. Barnes, S. Gordeuk, A. K. Anderson, and G. O. Bressler, "Newcastle Disease Affects Egg Production and Egg Quality," *Science for the Farmer*, Vol. 2, Pennsylvania State Coll., State College, Pa., 1954.

Treatment: Control by vaccination. Newcastle does not spread with the same speed or devastation as infectious bronchitis and can often be confined to a certain pen or house. Where the disease is in a community, the danger on any particular farm should be eliminated. This is done by giving the chick at 2 to 3 days of age a temporary intranasal or intraocular dose of vaccine, placing one drop in the eye or nasal opening. Follow at 8 to 10 weeks with permanent immunization by the wing-web method, using a live-virus Newcastle vaccine.

Experimental methods of control: A method of applying vaccine by spraying over the heads of chicks has been devised. A single operator can spray 10,000 chicks in 45 minutes, resulting in an enormous saving in time. A dust has also been devised to be dispersed by a hand-operated dust gun. The dispensation of vaccine in the drinking water is being tested experimentally and practically in some cases. In the United States the spray, dust, and water methods are still in the experimental stage.

For adult birds, it is possible that eliminating the use of lights for a period may be helpful to egg quality, as suggested in the treatment for bronchitis. Communicate with the state poultry disease laboratory or your state college experiment station or extension service for recommendations.

Prolapse of oviduct

In the process of laying, a larger part of the oviduct than usual is left protruding from the vent. Occasionally the oviduct containing the egg will hang from the vent.

Cause: Possible causes are eggs too large for the oviduct opening or restriction of it through swelling. This prevents the easy passage of the egg, causes the fowl to strain in an effort to expel the egg, frequently results in breaking the membranes with consequent eversion, and often starts the vice of cannibalism or "pickouts." It frequently occurs with pullets in the fall or early spring and may occur with hens.

Treatment: In most cases, kill and use the bird.

Respiratory distress troubles

Several of the diseases, parasites, and individual troubles cause difficult breathing and, in some cases, extreme gasping. These are grouped alphabetically below and are discussed on the pages indicated.

Air-sac mites, page 283.
 Aspergillosis, page 266.
 Bronchitis, infectious, page 266.
 Chicken or fowl pox, page 268.
 Cholera, page 271.
 Chronic respiratory disease (C.R.D.),
 page 272.

Coryza, infectious, page 273.
 Dropsy or water belly, page 274.
 Lack of vitamin A, page 134.
 Laryngotracheitis, infectious, page
 276.
 Lymphomatosis, visceral, page 278.
 Newcastle disease, page 279.

Tuberculosis

Tuberculosis is a disease much more prominent in some sections of the United States than in others.

Cause: Fowls become infected by eating food, soil, etc., on which bacteria from the droppings of tuberculous fowls are deposited.

Treatment: The disease is incurable. Eliminate all birds suspected of being tuberculous. Where flocks are badly infected, the best authorities recommend disposing of all birds. The disease, it is believed, is not transmitted through the egg, and therefore pullets reared on new ground and in clean buildings should be disease free. Disinfect the houses and equipment. Rotate ranges.

Manage the flock to insure strong, high-vitality birds which are able to throw off the disease.

The diagnosis of tuberculosis in the living fowl is possible by means of the tuberculin test, which is made by injecting $\frac{1}{15}$ to $\frac{1}{20}$ cubic centimeter of a substance known as tuberculin into the skin of the wattle. If an injected bird has tuberculosis, the wattle will swell within 48 to 72 hours.

Tumors

Cause and treatment not definitely known.

Vent gleet

Cause: The cause has not been fully determined. It is evidently a venereal disease, spread in the flock principally by the male. The cankers in the vent have a putrid odor.

Treatment: Remove all affected birds. Examine the vent of the male carefully for the symptoms. Vent gleet usually starts with the female and is then spread to other hens by the male. It is seldom worth while to attempt a cure, although softening with Carbolated Vaseline and painting with iodine may help.

Air-sac mites

Cause: Small, yellow mites in the air passages and air sacs. The lining of the air passages is irritated by their sucking mouth parts (Fig. 143). The trouble is serious and it is difficult to rid a flock of it.

When not badly infested, birds show no signs of this trouble. After the mites become numerous enough to cause discomfort, the comb turns purple and the bird may cough and wheeze. In the movement of the body the bird appears awkward, and has a peculiar appearance of the back and shoulders, which gives it a more or less "hunched up" attitude.

Treatment: Remove suspected birds, kill, and examine the carcasses. If air-sac mites are found, cull rigidly. It is doubtful if a flock can be entirely rid of them, but they can be kept down. The only sure way of ridding the flock is to kill off and start new as outlined under tuberculosis. Keep young fowls.

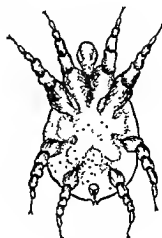


FIG. 143. The air-sac mite. Drawn from specimen under the microscope. (Greatly enlarged.)

Lice

Several species of lice live on the domestic fowl through their life cycle. They possess biting mouth parts, and irritate the bird by crawling as well as by biting the old scales, which serve as food. Lice spend their entire life on the fowl. The eggs are laid around the bases of the feathers, usually just below the vent and under the wings. Lice vary in size, some being very small and some $\frac{1}{8}$ inch long or longer.

Fortunately, lice are easily controlled, and anyone using ordinary precautions may keep the flock "louse free." The proper use of any of the following should prove effective.

Treatment: (a) Carbolineum will control body lice if it is properly applied to the perches as a mite preventive. Its effect on body lice ordinarily lasts part of a year.

(b) Blue ointment may be purchased at any drug store. It is easily applied and very effective. The flock should be treated twice each year, spring and fall. The effect of the ointment con-



FIG. 144. Machine used in debeaking poultry. The lever operates an electrically heated knife.

tinues for the time between. With the finger, apply a piece about the size of a pea on the skin beneath the vent. Give two or three rubs to make sure that no large pieces remain on the feathers. Place the same amount under each wing, on the bare spot at the base of the wing. Blue ointment is a poison and should be handled cautiously. This treatment involves individual bird handling.

(c) Sodium fluoride (first advocated by the Bureau of Entomology, U. S. Department of Agriculture) is a white powder which may be secured at a drug store. Hold the bird head down and scatter a few pinches through the feathers on the breast, thigh, below the vent, on each side of the back, neck, and on the head. Repeat when necessary, perhaps twice a year. It involves individual bird handling.

(d) Blackleaf 40 is expensive but quite efficient. Use an oil can for the liquid. About 1 hour before roosting, apply two lines on top of the perch, or with brush spread 8 ounces to each 100 feet of perch. House temperature should not be lower than 60 degrees F. Adequate ventilation must be provided. Be sure all birds go to roost where the material has been placed. Repeat 3 nights in succession and again in about 3 weeks to kill any lice that hatch after the first treatment.

(e) Lindane, 0.25 per cent (1 part 20 per cent Lindane emulsion

to 79 parts of water). Apply as a single spray treatment to *all* roosting areas.

In roostless houses, it may be used as a vapor from electric vaporizers. Use pure Lindane, 1 gram to 20,000 cubic feet of laying-house volume, to be sprayed daily for 14 continuous days.

Red mites

These are very small and difficult to see during the afternoon or toward evening. At this time they are gray. After feeding, they are gorged with blood and are red.

The mites do not stay on the birds constantly. They spend the day on the underside of the perches or in cracks and crevices nearby. At night they crawl on to the birds and fill themselves with blood, piercing the skin with their sucking mouth parts. Before morning, they leave to spend the day nearby, digesting the blood.

Mites breed rapidly, increasing in numbers at an astonishing rate during warm weather. Filthy conditions aid their breeding.

After a few days of warm weather, if they are allowed to go unchecked, great clumps and masses of the mites may be found. Examine the underside of the perches and the places where they rest on the perch supports. In all probability a wriggling mass will be seen. If left unchecked, mites will be found in cracks in all parts of the house, more especially where birds roost in several places about the house or shelter. The mites are surprisingly tenacious of life. They survive several months after the building has been unused by fowls.

Mites sometimes infest the nests and feed on birds which go on the nest to lay. They cause a decrease in egg production, and frequently death results from their attacks. It is impossible for birds to function normally where the red mite is present.

Small grayish specks, the cast-off skins, indicate the presence of mites.

Control is comparatively simple. Paint the roosts, roost supports, and nests with Carbolineum or other good mite repellent.

Carbolineum holds its strength for one year and at the same time proves effective in combating body lice and disease germs.

Carbolineum is not a coal-tar solution, nor is it soluble in water or petroleum oils. Its efficiency is **not** due to its content of tar acids, as it contains less than 2 per cent of such. The germicidal or vermicide effect of Carbolineum is due to the fact that it passes through a process

of chlorination and for this reason also it does not mix with petroleum oils, and the genuine goods if mixed with such will invariably show a sticky precipitation which will clog the sprayer as well as the brush. For use in poultry houses, Carbolineum is always recommended to be used full strength.*

When the entire house is infested, a thorough cleaning and spraying are necessary to rid the house of the pests. A single spray of 4 per cent D.D.T. is effective.

Brooder houses (see page 2).

Disinfectant danger in brooders. Coal-tar products (cresylic acid types) are a source of danger when improperly used. If they are not dried thoroughly or washed out after disinfecting, the fumes resulting when these products are heated by the brooder stove may cause death or serious disability. Disinfect or paint brooder houses, and when they are reasonably dry, wash them out with cold water.

There is no similar problem with hens.

Roundworms

Presence of a few roundworms or of coccidiosis oocysts is no cause for great alarm, but is a warning to the poultryman. Should there be so many worms that they "knot up" in the intestines and large masses be found when the birds are posted, then their presence is economically harmful.

The problem with adults should not prove serious, but it may be serious with pullets if infested when brought in from range. However, if worms are found then, it denotes unsound range management and, obviously, worms will appear in the birds during the first laying year. See page 287 for the life cycle of roundworms.

There are several kinds of roundworms that infest chickens. The spread of these parasites and methods of treatment are similar for all. The infestation is *direct*, that is, the worm eggs are given off in the droppings of the chicken, pass through a period of embryonic development, and are then eaten by another bird or birds.

How serious the infestation is depends on the number of worm eggs a bird eats. If the worm eggs are numerous, many become

* From descriptive material published by the company, and quoted because the statements seem to be borne out in practice, in cases where there has been opportunity to use Carbolineum in various ways.

attached to the particles that the bird continually picks up from the litter.

A serious infestation of worms generally can be detected by an unthrifty appearance of the birds. They lose weight and in some cases become extremely thin or emaciated. The comb and wattles become pale. If this condition develops, some of the birds should be killed and examined internally. If worms are found, thus verifying the external symptoms, immediate steps should be taken to free the flock of the parasite.

The large intestinal roundworms are white, pointed at both ends, and from 1 to 3½ inches in length (Fig. 139). They are unattached to the intestine.

Treatment: Prevention is the best treatment. *Alternate ranges* have practically eliminated the roundworm trouble in certain sections. The reason appears to be as follows. Worm eggs deposited on the ground from infected birds or manure remain without change through the winter. In the spring, warmth and moisture result in embryonic development inside the worm-egg shell. In this condition they can infect a chicken if the egg is eaten, but by ranging on other land the egg is not consumed. The following winter weather kills the partially developed worm embryo, and the next spring the range is safe for range use. Whether on reused land or on reused litter, the development of worms is similar unless the worm-egg cycle is broken.

To break the cycle when *built-up* or *compost litter* is used for hens:

(1) House pullets that are not infected by using alternate ranges or clean confinement brooding and rearing. Worms or worm eggs *must* enter the house and the litter before trouble can develop.*

(2) Remove the top inch of litter when it becomes damp or packed down, prevent wet conditions around water dishes, and use an efficient ventilation system. *If these conditions cannot be met*, then remove the litter completely annually and renew before placing new pullets in the pens.

Tobacco dust for flock treatment or nicotine sulphate capsules

*D. C. Kennard, E. N. Moore, and V. D. Chamberlain, "The Role of Floor Litter Management in Nutrition and Disease Prevention of Chickens," *Mimeo. Series No. 39*, Ohio Agr. Exp. Sta., Wooster, July 1954; F. R. Koutz, "The Effect of Built-up Litter on the Parasite Ova and Oocysts of Poultry," *Poultry Sci.*, March 1953, p. 313.

or pills for individual treatment are effective for expelling round-worms.

Method of treatment with tobacco dust. To each 50 pounds of dry mash add 1 pound of tobacco dust, containing $1\frac{1}{2}$ to 2 per cent nicotine, and mix thoroughly. Not over 1 week's supply should be mixed at one time. Feed this mixture to the birds in place of the regular mash. No other change of feeding is necessary, provided the method used has proved satisfactory. Feed the tobacco dust daily for 3 or 4 weeks.

Scaly leg mite

Scaly leg is caused by a microscopic mite which burrows beneath the scales of the shank, causing the scales to stand out. In very severe cases, the shanks have great knobs, parts of which may be cracked and bleeding. The trouble is likely to spread.

Treatment: Use precautions described for red mites and lice. Dipping the shanks only in kerosene may be effective.

Tapeworms

These worms fasten themselves to the walls of the intestines by means of hooks in the head end. The body of the parasite is segmented, the segments growing larger the farther they are from the head. The older segments develop sexually and become filled with eggs. These segments drop off, pass out with the droppings, disintegrate, and the eggs are eaten by an intermediate host, such as a slug or certain types of beetles. Later these may be eaten by a fowl, and the cycle is completed.

Treatment: No treatment is known that is 100 per cent efficient. As an intermediate host is necessary for subsequent infestation, control consists in breaking the cycle.

Rear on clean ground where no manure has been spread and no chickens have ranged for at least 2 years. An open range is preferred. Avoid naturally damp, shaded areas. Rotate ranges. Consider the possibility of infestation from neighboring poultry plants.

Confinement rearing on properly cared for litter should offer no particular problem with this pest.

Several remedies have been tried but have not been found effective in removing the tapeworm beads, although certain of them remove the bodies. The bodies grow out again in 1 to 2 weeks. The best treatment is prevention.

Under date of October 18, 1932, the Food and Drug Administration of the U. S. Department of Agriculture issued a trade notice as follows: "Government tests showed definitely that these types of preparations [combinations of nicotine sulphate and kamala and also iodine products], although labeled as being effective for roundworms and tapeworms in chickens and turkeys, are not effective in expelling any species of tapeworms which commonly infest chickens and turkeys nor any species of roundworms other than the large roundworm. No drug or mixture of drugs known at the present time can be truthfully offered to the public as an expeller or vermifuge for all types of worms which infest poultry and other animals."

Cannibalism

The reason for this vice cannot always be explained. Classed under this heading are various kinds of picking, as toe, feather, back or sides, and cloaca or vent. Toe, tail, and feather picking often occur among *chicks* at 3 to 5 weeks of age if they are *overcrowded*, *have too little feeding space*, or are kept under *too high temperature* (see Chapter 1). Chicks will often pick the new quills and later follow along these quills with their beaks to take off the blood.

Picking is most common with *adults* during the first laying year.

"Pickouts" may result from prolapse cases, but not necessarily so. Picking often occurs when, immediately after laying, the oviduct protrudes slightly for a short time. Floor layers are often victims.

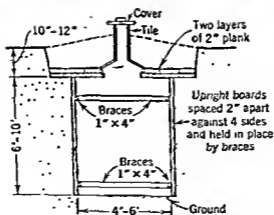
Control: (a) *Chicks*—Put pine tar or an "anti-pick salve" on the injured part and release the chick.

(b) *Adults*—*Debeaking*. Since the cause of cannibalism is not definitely known, debeaking offers the quickest and cheapest preventive. As pullets are housed or when picking commences, $\frac{1}{4}$ inch of the upper beak is cut off. The cut surface must be seared to stop bleeding. A debeaking machine is available at poultry supply houses. The cutting blade is electrically heated, and it cuts and sears at the same time. Debeaking does not interfere with eating or drinking. Feed grain in troughs for at least a few days after cutting.

Mechanical devices may be placed on the birds. One type hangs over the vent and others fasten on the beak.



A



B

FIG. 145. The last trip when all else fails A. Dropping a dead bird in the disposal pit, a quick and efficient method of handling a common problem on the poultry farm. B. Cross section of a disposal pit.

Egg eating

This vice seldom develops among birds that are kept occupied, have ample and proper feed, and are given sufficient nesting material. Gather the eggs 3 to 4 times daily. Deepen the litter and darken the nests. See that ample oyster shell and vitamin D are supplied. Provide for direct sunlight. Feeding milk for a few days may help.

Community Survey

1. What diseases, parasites, or pests are found among local poultry flocks?

2. What diseases or troubles are most prevalent?

3. How do the poultrymen determine what their poultry troubles are? By personal diagnosis? Poultry disease laboratory? Neighbors? Feed service man? Other?

4. If a poultry disease laboratory or a college poultry department is within driving distance, take a few diseased birds to them, note their method of diagnosis, how they arrive at the trouble, and the precautions they suggest to prevent spreading any disease to other flocks.

5. Arrange with a local poultryman to examine all birds that die during 1 or more months. Determine the cause of death by a post-mortem examination on as many as possible. Keep a count of the number that die from each cause and the number you cannot diagnose.

6. What is the percentage of mortality in the flock for the period examined?

7. In what way, if any, might this percentage be decreased?

References

- Carpenter, K. J., "Results of Experimental Trials with Antibiotics," *World's Poultry Sci. J.*, January-March 1953, p. 16.
 McKay, W., "Practical Application of Antibiotics," *World's Poultry Sci. J.*, January-March 1953, p. 20.
 Wilson, J. E., "Recent Developments in Poultry Diseases," *World's Poultry Sci. J.*, July-September 1954, p. 252.

Culling the Flock

One of the most useful, satisfying, instructive, and inspiring types of work with poultry is culling the flock.

Culling is useful because it gives the good producers more room at feeding time, less crowded perches, and cooler quarters at night. It is satisfying because it enables the poultryman to eliminate the poor producers, saves feeding them when no return for eggs can be expected, and places them on the market at the time of higher prices. It is instructive because the observing person will learn much about poultry by handling the birds individually. Finally, culling is inspiring because one can quickly see results. It leads to the habit of observing daily the quality and condition of the stock, and creates a desire for continual improvement.*

Operations:

1. Deciding when to cull.
2. Deciding upon the culling method to use.
3. Preparing to cull.
4. Catching the birds.
5. Holding the birds while culling.
6. Culling the birds that are not laying.
7. Continuing the examination.
8. Comparing good and poor laying hens.
9. Studying pullets approaching sexual maturity.

Operations

1. Deciding when to cull

Cull throughout the year by removing birds that appear to be out of condition or not laying. Occasionally birds out of produc-

* Breeders of certain strains are now advocating less need for vigorous culling. The operations suggested here are still important to most poultrymen.

tion are found at other than the regular culling season. Such birds may have soft, deep, but not full abdomens, strong heads and bodies, and may show otherwise that they have been fine producers. They may be left in and given an opportunity to come back into production. A few unproductive birds may be found at almost any time, and may be used in the home or frozen or canned for future consumption, or sent to market if there is a sufficient number of them.

If a large percentage of the flock is out of production before the end of its normal laying year, the fault may be poor feeding, lack of sufficient water, too little fresh air, other mismanagement, extremely cold or warm weather, vermin, or the inherited ability of the flock. Disease may be present. Well cared for and well-bred flocks should lay at least 6 to 8 months before very many individuals reach the end of their first laying year.

Many hens do not lay simply because they cannot under existing management conditions, even though they may have the inherited ability to lay. Under such circumstances, if all nonlaying birds were removed at this time, valuable hens might be culled. Where there is reason to suspect wrong management conditions, the hens should be culled less severely, and if feed costs are not excessive the flock should be placed under desirable conditions at once. Culling may proceed after a month or 6 weeks. If a flock has been properly cared for, the few poor producers that may be found may be culled at any time.

The majority of birds complete their first laying year after producing for 12 to 18 months, or during the second fall after hatching. At that time all may be culled whether laying or not, or the best $\frac{1}{4}$ to $\frac{1}{2}$ of the original flock may be separated, rested, and held for a second year of production, depending on the number of pullets available. See pages 153 and 154.

2. Deciding upon the culling method to use

If only a few birds have ceased laying, they may be removed by carefully separating them from the flock and catching them in the pen with hook or net. If the entire flock needs to be handled, two methods of systematic culling are practiced: (a) by trapnest or laying-cage records, and (b) by external characters.

Culling by trapnest alone is not practical. It involves trapping the flock and removing from the pen any birds that are recorded as not laying sufficiently well to make desirable laying or breeding

birds. This procedure requires a great deal of labor and is very expensive. Laying cages also give individual egg records. Neither trapnests nor laying cages should be relied upon as the sole means of culling. A knowledge of the external characters is always desirable.

3. Preparing to cull

- (a) Become acquainted with the conditions under which the flock has been kept.
- (b) Provide a place in which to put the culled birds.
- (c) Confine the hens to their house or pens the night before they are to be culled.
- (d) Prepare the equipment for catching and confining the birds.

4. Catching the birds

- (a) *Night flashlight culling.* Pass in front or rear of the perches and, by flashlight, remove birds with shrunken, hard, limp, dis-



FIG. 146. Culling the flock by flashlight at night. A quick examination of the comb, other head parts, and the plumage results in rapid and reasonably accurate culling. (Taken by Cornell University. H. E. Botsford culling personal flock.)

colored combs or obvious molt. Place in crates or cull pen. If the hens leave the perches, subdue the light with one or two fingers.

Next morning handle each bird and either cull or keep. A reasonably complete job of culling can be done this way quickly, easily, and with little disturbance.

(b) One daytime method is to place a catching and carrying crate (Fig. 147) at the exit door, on the outside or between pens. (The exit door should be in a corner of the pen, to facilitate driving.) Drive 20 to 30 birds into the crate, depending upon the size of the crate.

(c) The *net* may be used to advantage when one wishes to catch a few birds rather than handle the entire flock. The bird desired may be carefully separated from the rest of the flock and caught without disturbing the others (Figs. 148 and 149). Some prefer to use the *catching hook* (Fig. 150).



FIG. 147. Catching crate in position. Note sliding door and handle. The crate is convenient for use in culling or moving chickens.

(d) Rounding up with *wire screen or panel* is a satisfactory method using 10 to 15 feet of poultry fencing, 5 to 6 feet high. Fasten one end to the wall 4 or 5 feet from a corner and hold the

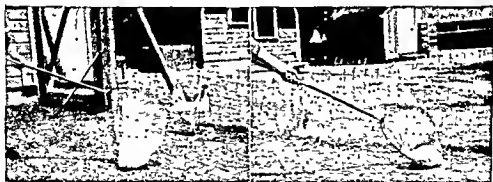


FIG. 148. A fish landing net is ideal for catching birds. Approach the hen quietly and with a quick movement slip the mouth of the net over her head. Bird is caught but is neither harmed nor disturbed.

other end out into the room. Drive 20 to 25 birds toward the corner, carrying the loose end of the fencing around them. The person operating the fencing should be inside the pen as the fencing is drawn closer. Fasten the end to the wall when the space inside



FIG. 149. Catching wild or frightened birds. Start the bird running beside a fence or building and suddenly thrust the net in front of the bird, which runs into it.



FIG. 150. The three parts of a desirable catching hook: *A*, handle with hole bored in the end and with hole in the side for the nut; *B*, nut; *C*, hook which enters the hole and screws into the nut. The wire found in roofing paper makes a satisfactory hook.



FIG. 151. Using the catching hook. The hook is slipped around the shank. The foot prevents the leg from slipping through.

is small enough. Pick up the birds and pass them over the wire to the person culling.

Pens may be arranged outside, by using catching crates or wire.

5. Holding the birds while culling

The following manner of holding the birds will be found convenient for right-handed persons. A left-handed person may desire to do just the opposite.

By grasping the wing close to the body (Fig. 152), lift the bird to be examined from the floor, pen, or catching crate. Hold the left hand flat in front of the body with the back of the hand toward the ground, thumb pointing away from the body, fingers together and at right angles to the thumb.

With the bird's head toward you and the legs straight out behind, place the legs in your left hand so that the hock joint rests just at the edge of the hand near the forefinger. Grasp the legs with the thumb and fingers (Fig. 153).

Support the bird by placing the fingers of the right hand on its breast. If the left hand is too far down; toward the feet or above the hock joint, the bird can bend its legs and may flop and cause trouble in holding; but when it is held as described, the legs are kept straight by the use of the forefinger and cannot be bent enough to become unwieldy.

The bird may now be turned in any direction for examination without releasing the left hand, the right hand being used to help turn and hold the bird's body.



FIG. 152. Lifting a bird from a catching crate.

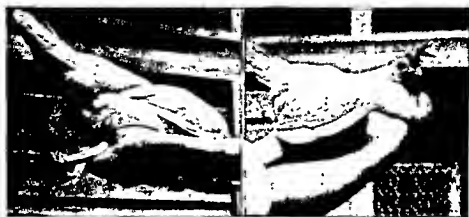


FIG. 153. *Left:* Grasping the legs preparatory to examining a bird. *Right:* Bird in position for examination.

6. Culling the birds that are not laying

A hen that has recently been broody, although perhaps not laying, should not be culled unless she has been broody at least twice or it is late in the season. (See Chapter 7 for method of marking broody hens.)

Sick birds should be culled. In most cases they will not be laying.

Examine the hen, whether separating individuals on the floor



FIG. 154. High producer, full laying. Note full, bright, stiff, waxy comb and wattles; pale color of beak, eyering, earlobes, face; bright, round eye.



FIG. 155. Low producer, not laying. Note small, hard, dried, scale-covered comb and wattles; yellow color of beak, eyering, earlobes, face; dull, snakey eye.

or handling every bird, looking for the characters described in the following paragraphs in the order in which they are given. These characters indicate a hen that is definitely out of production. If any character is not as pronounced as here indicated, and if there is any doubt whether the hen is laying or not laying, check it with the other characters mentioned.

Examining the comb, corner of mouth, vent, and plumage. When the comb is shriveled and dry, it is a sign that the bird is either out of production or is slacking up in her laying (Fig. 155).

While holding the bird in the left hand, grasp the wattles with thumb and middle finger of the right hand, place the forefinger on the tip of the upper beak and force open $\frac{1}{8}$ inch. Examine the base or corner of the beak where the skin joins the upper and lower mandibles. Pale yellow or deep yellow color there shows production has slowed down or stopped.

Still holding the legs, place the back of the bird against you and, with the fingers of the right hand, part the feathers until the vent is exposed. In most cases when the comb is as described above, the vent will be dry, puckered, and yellow (Figs. 156 and 157), indicating that the hen is not laying. (For white-skinned varieties, such as Orpingtons, Minorcas, etc., the yellow test does not apply.)



FIG. 156. Laying. Note distance from rear end of keel to vent; large, dilated, loose vent; pubic bones wide apart.



FIG. 157. Nonlaying. Note hard, plump condition of the body, contracted vent, and close pubic bones.

Now look among the neck and body feathers for signs of a molt, and see if there are pinfeathers or if there are unmistakable signs that the old feathers are being dropped and new ones growing in. New feathers are bright, and in many of the newer ones there will be bloody liquid in the quill at the base. Old feathers are usually worn, soiled, and perfectly dry at the base. A bird shedding her coat early in the summer is likely to be out of laying. (See page 312, molt.)

Hens that appear as just described are not laying and may be removed from the flock.

On many hens, however, these characters may not be clearly marked; and when one is not sure whether the bird is laying, it is well to check further.

7. Continuing the examination

The following characters indicate that a bird has not recently laid heavily.

Beak. Pale yellow or deep yellow color extending, with no break in color, part or all the way to the tip.

Eyering. Pale yellow or deep yellow on the eyering or the inner edge of the eyelid next to the eyeball. (When the eye is open, the inner edge of the lower and upper eyelids form a ring known as the eyering.)

Earlobe. Pale yellow or deep yellow on the earlobes of white-earlobed breeds.

Pubic bones. Thick, blunt pubic bones which are close together. (These are the two bones just below and on either side of the vent.)



FIG. 158. Front view of bird in Fig. 151. Note full comb and wattles.



FIG. 159. Front view of bird in Fig. 155. Note shrunken comb and wattles.

Abdomen. A shrunken "tucked up" abdomen or one filled with a hard material (Fig. 160).

8. Comparing good and poor laying hens

Because many hens do not show these characters as definitely or in as advanced a form as just described, further study may be desirable.

Culling poultry is a balancing of characters; one should be checked with another. Except in extreme or unmistakable cases, and until one has had considerable experience, hens should not be culled on the basis of any one character alone.

When learning to cull, practice studying each character. Later, one should take in several characters at a glance, weigh them mentally, and arrive quickly at a decision.

It is well also for beginners, while learning to test the accuracy of their work, to keep the culled birds a week or so.

The following characters, as found on a good and on a poor

layer during the summer, are arranged for quick reference (Table 22). The longer the hen is *out of production*, the more the poor layer's characters will be intensified.

The beginner should work through the characters given in the preceding paragraphs until they are clearly in mind.

(For selecting birds while in laying condition or when both good and poor hens are laying or not laying, see Chapter 17.)



FIG. 160. Testing the abdomen. On removing the hand, press gently with the thumb and fingers. A soft, pliable abdomen often allows the fingers to meet with only skin between. The abdomen of a poor producer may be filled with fat and be hard, preventing the fingers from meeting.

9. Studying pullets approaching sexual maturity

Flocks from which extremely small or thin pullets and those having deformed backs, cross beaks, or irregular pupils* have been removed when noticed during the rearing season and again when handled and housed may be considered well culled.

Pullets showing little or no comb development should be left on range until nearly ready to lay. If it is necessary to house them earlier, place them in a separate pen until mature, when they should be placed in the laying flock.

Modern breeding, nutrition, and management have resulted in many fine breeding flocks. Pullets from such flocks increase the tendency toward uniform sexual development. Only a few pullets

*Consider the color of the eye cautiously when studying Leghorns, since it may be related to the ration fed. Rations with yellow pigment cause yellow to be deposited in the iris; rations without yellow pigment do not. Laying pullets, in tests at Cornell, did not store the pigment, and well-pigmented irises faded when the birds were fed pigment-free rations. Also there is no important relation between the iris color in dams and the mortality of the progeny. (See page 276, iritis.)

Table 22. Characters of Good and Poor Layers

GOOD LAYER

POOR LAYER

Comb

Large, full, plump, smooth, waxy. If the comb is cold, but of good size and full, she is laying regularly.

Limp (if laying slightly). May be covered with white scales.

Beak

White or well bleached.

All or partly yellow. Yellow color at the base of the beak, and extending out toward the tip.

Eyering and Earlobe

White or well bleached.

Yellow or tinted.

Vent

White or well bleached. Large, soft, moist, oval. Sometimes its fullness causes the upper part to appear overhanging.

Yellow or tinted. Small, hard, dry, round. Sometimes appears contracted.

Molt

Sheds late and rapidly.

Sheds early or before September and usually slowly.

Pubic Bones

Thin, pliable, and relatively wide apart.

Thick, blunt, and relatively close together.

Abdomen

Loose, pliable, soft. Full when in laying condition. Deep from the pubic bones to the rear of the keel.

Tight, hard, tucked up. Rear end of the keel rather close to the pubic bones.

are likely to be found in the separate pen 2 months after the main flock is laying. In most cases these few should be culled.

Early sexual maturity. Other things being equal, the pullets that are well developed usually begin to lay earliest. A bird is said to be sexually mature when she starts to lay. Sexual maturity and physical maturity (maximum body weight) do not necessarily occur at the same time. Pullets reach physical maturity at about 10 months of age, but sexual maturity may be reached much earlier in life.

For several months, pullets which have reached sexual maturity early are producing eggs and growing at the same time.

Leghorns should reach sexual maturity between 5 and 6½



FIG. 161. A good layer. Note pale color of beak, eyering, earlobes, face, shanks; old, unmolted, ragged plumage; full, bright, waxy comb; full earlobes; deep abdomen; intelligent head.



FIG. 162. A poor layer. Note yellow color of head, shanks, plumage; new plumage; small, hard, dried, scale-covered comb; wrinkled earlobes; tucked-up abdomen, full face.

months, 150 to 195 days, and reach full production at 6 to 7 months, depending on the season hatched. Heavier varieties should reach sexual maturity at 6 to 7½ months of age, 180 to 225 days. Certain strains are bred to lay earlier or later than other strains.

Ordinarily birds reaching sexual maturity early are heavier than those not yet laying. However, being young, they are of small size, and their eggs are small at the start. As they grow, their eggs increase in size. Pullets reaching sexual maturity late are larger when laying starts and lay larger eggs because of their larger bodies.

The season of hatching affects age at sexual maturity. Birds approaching sexual maturity as days are shortening and becoming cooler start laying later in life, while those approaching sexual maturity during the long, warm summer days start laying early in life.*

Sexual maturity is indicated by the development of the comb, size and condition of the vent, fullness of abdomen, and amount of pigmentation. The pigmentation of a bird just starting to lay is exactly the reverse of that found in a high-producing hen ceasing to lay.

* Botsford, *The Economics of Poultry Management*, Chapter 6.

The eyerings, earlobes, and vent will begin to bleach. If it is desired to examine a pullet, examine the beak at the base. If the pullet is laying and has laid several eggs, that section of the beak will be pale. The longer she has been laying, the lighter the beak will be and the nearer the tip the white part will extend. The degree of bleaching present depends on the number and size of eggs, the rapidity of laying, and the kind of feed given.

Community Survey

1. How many poultrymen in the community cull birds the year around?
2. In which months is heaviest culling done?
3. Visit several poultry keepers and get from each the following information. Use it as a basis for class discussion.
 - (a) When are pullets placed in permanent laying quarters?
 - (b) Number of layers on that date? Old? Young?
 - (c) When does culling start?
 - (d) How often and when were the flocks culled?
 - (e) Approximately how many were culled each time? Per cent culled?
 - (f) What price per pound was received for each lot of culls?
 - (g) What effect, if any, was noticed on the flock after culling?
 - (h) What method of catching the birds is used?
 - (i) What percentage of the entire flock was culled during the year?
4. What percentage of the pullets are usually culled out when housed?
5. What points are considered undesirable in the culled pullets?

References

Write your own state college of agriculture for pamphlets and guides to culling.

Hall, G. O., and D. R. Marble, "Culling for Egg Production," *Cornell Ext. Bull.* 887, Cornell Univ., Ithaca, N. Y., reprinted July 1954.

Rice, J. E., G. O. Hall, and D. R. Marble, *Judging Poultry for Production*, John Wiley & Sons, New York, 1930

Staff, "Guide to Culling Hens," *Ext. Circ.* 78, Ontario Agr. Coll., Guelph, Ontario, Canada, 1950.

Principles of Selection

In the commercial culling of poultry, it is comparatively easy to recognize the extremes of laying quality. The difficulty arises in working with medium birds. With a knowledge of the reasons why the various characters are significant, one is better able to form a correct judgment regarding the value of any particular character or group of characters. In general, these rules apply:

(1) The pullet that began to lay late in life, compared to the normal for the group of the same age, is likely to stop early.

(2) The pullet that starts to lay early in life usually lays late.

All individuals in a flock do not inherit the same characteristics, but the tendency to do so is more apparent in many flocks today than it was a generation ago. Flocks may and often do reach peak production $1\frac{1}{2}$ to 2 months after starting to lay, because of the advance of breeding, nutrition, and management in recent years. The spread between individuals in a flock is not so great at the start of laying.

Total production begins to decrease after a few months of laying. Those lacking staying power are the birds to be culled. Many of these are the ones that began to lay comparatively late in life. Mortality takes its toll. Their lack of persistency in laying can often be traced to an abnormality in the body, or to a lack of aggressiveness which prevents them from getting sufficient food or water.

Of the individuals comprising the group from which the early production of the flock came, many will be laying until the end of the flock laying year. They are usually unafraid of their pen mates and are for the most part busily engaged in eating, drinking and laying. They are the ones in the process of building a long laying period and, hence, a high egg record.

In a majority of cases, the bird having the short laying period

does not lay as many eggs in a given week or month as the longer laying hen, that is, she is not as intensive a layer.

The principles of selection associated with the length of laying period and high production are the related factors, precocity, intensity, and persistency.

General information:

1. Five important characters.
2. Precocity.
3. Intensity.
4. Persistency.
5. Exceptions.
6. Egg quality.
7. Season of laying as an indication of egg production.

1. Five important characters

There are five factors generally accepted in research and commercial breeding work as associated with high production. They can be used to judge the value of an individual as a producer, or the daughters may be measured by them to judge the value of either the dam or the sire as a breeder. The factors may be rated as follows with respect to their effect on annual first-year production: *persistency, intensity, no winter pause, nonbroodiness, and precocity.*

The importance of possessing as many of these characters as possible is shown in Table 23.

Table 23. Effects of Character Factors

Rhode Island Reds, Massachusetts Agricultural Experiment Station,
1938-1942¹

Number of Desirable Characters	Number of Birds	Per Cent of Birds	Average Egg Production
1	10	0.82	125
2	69	5.66	157
3	393	32.21	188
4	439	35.98	224
5	309	25.33	252

Total birds 1220

¹ F. A. Hays, "The Significance of Inherited Characters Affecting Egg Production," *Poultry Sci.*, July 1944, p. 310.

Table 24. Suggested Standards for Selection of Breeders

	By Hays for R. I. Reds	By Authors for W. Leghorns
Age at first egg	215 days or less	180
Weight at first egg	5.5 lb. or more	3½
Intensity (winter cycle size)	3 or more eggs	3
No winter pause of more than	8 days	8
No broodiness	No broodiness	No broodiness
Persistency	280 days or more	315 or more
Egg size	<div style="border-left: 1px solid black; border-right: 1px solid black; padding: 0 10px;"> Not under 24½ oz. for pullets Not under 26 oz. for hens </div>	24 oz.
Laying-house mortality	Not over 15%	15%

2. Precocity

Precocity refers to a pullet's ability to lay her first egg at an early age. It is spoken of as *early sexual maturity*. It is inherited and is an index of the ability of pullets as egg producers, because pullets possessing it are likely to lay more eggs in a month and to continue to lay longer near the end of the production year. That is, early sexual maturity is often associated with greater *intensity* of production and more *persistent* production.

Precocity is a valuable factor but a less reliable index of inheritance of production than persistency, because it may be influenced by rearing conditions or by the management of the flock when placed in winter quarters.

Apparent early sexual maturity may occur when artificial illumination is used too soon on pullets. Pullets should come into production normally without the stimulating effect of illumination. Resort to that only after the pullets are laying well and cold weather or other influences seem likely to reduce the amount of feed the birds are consuming. Illumination may also be used on late-hatched pullets that are well grown but not laying when cold weather is approaching and short daylight hours prevail. This practice permits both physical and sexual maturity to proceed normally. However, too early sexual maturity may result in small bodies and small eggs.

Precocity is best used in selecting pullets for egg production when desirable rearing and laying-house management has permitted them to develop normally, without the retarding effect of crowding and

wrong feeding or the stimulating effect of too early artificial illumination. The inherited ability of the pullet can then express itself better, and the flock can be selected by the operator more satisfactorily.

Caution: There are likely to be a few slow-developing pullets. When pullets are housed, these should be left on range or kept in a separate pen until ready to lay, after which they may be placed with the pullets previously housed. Poorly developed pullets and pullets which show no signs of becoming potential layers should be marketed or used at home.

3. Intensity

The *intensity* of production is a very reliable index of a bird's inherited tendency to lay. It is affected by management in about the same way as precocity and persistency.

Intensity is measured by the number of eggs per month or week, or the number of eggs that a hen will lay without skipping a day. Certain hens may have a monthly intensity of only 8, 10, 12, or 15 eggs, whereas others will lay 20 or even 30 eggs. The intensity can be measured at any time when the fowls are laying normally. It can be accurately measured only by the trapnest or when the layers are in laying cages. Evidence of high production combined with an excellent body type has been used as an indication of intensity.

Intimately associated with intensity are *cycle* and *rhythm*. The length of the cycle is the number of successive days on which the hen lays an egg. This varies considerably among individual hens. The total production is greatly affected by the number of days in a cycle, that is, whether the hen lays one or more eggs before skipping a day.

Rhythm is the regularity of the cycles. One bird may skip a single day between cycles, whereas another may skip varying periods, from 2 days to a week or more.

The birds with the highest intensity are usually the best annual producers.

Winter pause may be several days skipped between cycles during the winter. It signifies a lack of power to carry on. A partial molt sometimes occurs. Days out of production mean lower annual production. Some research workers believe that winter pauses of 7 or more days are inherited, and that therefore such birds should be eliminated from the breeding flock. Pauses are not

limited to the winter period but may occur at other times of the year.

Broodiness influences the spring, summer, fall, and annual production, but such birds may have as high or higher winter production as those that are nonbroody. A bird may go broody once or several times during a season. In any event, time is lost, and the tendency should be to reduce the amount of broodiness where egg production is the aim of the breeder.

The broody tendency is inherited and can be greatly reduced by rigid selection. It is a very important factor in crossbred pullets.

4. Persistency

Persistency refers to a bird's ability to continue laying over a long period of months in her first laying year. The greater persistency a bird has, the longer will be her laying period. The sooner she ceases to lay after she has once started, the less persistent she is. The characters denoting whether a hen is laying or not have been discussed (see Chapter 16). They are pigmentation, molt, and condition of comb, vent, and abdomen.

Pigmentation. Pigmentation, an important indicator of production, is one of the first characters discovered. It was found helpful in judging whether hens were laying. It indicates what a fowl has done rather than what she will do, except as the future may be judged by the past. In other words, it may be used to estimate her past production and thus to form an opinion as to her probable future production.

On yellow-skinned varieties, the yellow color is given to the fat by a pigment called xanthophyll. It is found in the skin, in the shanks, beak, and all parts of the body. While the bird is not laying, the yellow pigment in the feeds eaten is carried by the blood to the body tissues and deposited in the fat just beneath the skin. This causes the yellow color in yellow-skinned varieties of poultry.

When the bird commences to lay and during the time she continues to lay, the yellow pigment is carried to the developing yolks and not to the body fat. The yellow pigment previously deposited in the body fat, not being replenished, is lost, presumably by oxidation. The loss of pigment is more pronounced in the softer parts of the body, where the skin is thinner.

From observations which have been made, it is possible to estimate the approximate length of time required for bleaching various parts of the body, and hence the time that has elapsed since the bird began to lay.

Vent. The vent loses color fast, owing to the stretching of that part by laying. As a result, a marked paleness is noticed after 2 or 3 eggs have been laid. (The corner of the mouth bleaches almost as rapidly.)

Eyering. The eyering, which is the inner edge of the eyelid, bleaches almost as fast as the vent. On Leghorns, the eyering in most cases can be seen plainly, but in heavier varieties considerable red may make the yellow less visible.

Earlobe. Since the earlobe has a larger surface, a bleached earlobe usually denotes at least 2 or 3 weeks of laying.

Beak. Soon after laying begins, the beak starts to bleach at the corner of the mouth. As the bird continues to lay, the color continues to disappear until the entire beak is bleached (*B*, Fig. 163). The lower mandible bleaches faster than the upper. The last place for the color to disappear is the arch at the front of the upper mandible (*E*, Fig. 163).

A well-bleached beak usually indicates 6 to 8 weeks of fairly heavy production.

Shanks. Color change in the scales of the shanks is very slow. Hence, a well-bleached shank shows good production for 4 to 6 months, depending upon the intensity of laying. The last places from which the yellow disappears are the scales just above the foot in front and the rear of the shank at the hock.

Pigmentation, therefore, indicates not only whether the bird is laying but also about how long she has been laying.

Consideration of pigment return when culling or selecting hens. When a hen ceases to lay, the yellow color is again deposited in the body as it was during the growing season. Fortunately, under normal conditions of feeding, it is deposited in the various parts of the body in the same order in which it was removed. It comes back slightly faster than it went out. Therefore, the pigment comes in first, as it went out first, in the softer parts, and in the following order: (a) vent and corner of the beak, (b) eyering, (c) earlobes, (d) beak, (e) shanks.

In a very few days after laying ceases, yellow color may be seen at the corner of the beak and in the skin about the edges of the vent. As time goes on, the pigment in each section deepens.

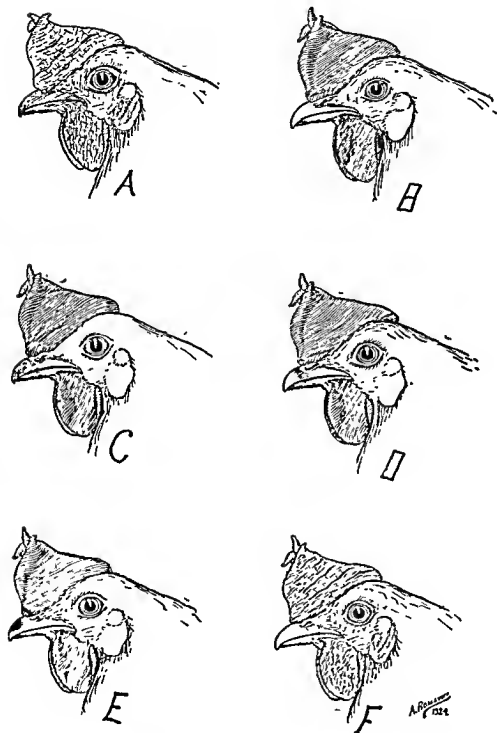


FIG. 163. A study in pigmentation (see text).

As previously indicated, hens should not be culled on the basis of yellow color in the front of the beak or in the shanks alone. The color change in these parts is so slow that the immediate production activity of the hen is better indicated by other characters.

A hen with very yellow beak and shanks ordinarily has not been laying very heavily for several months.

The beak may be used to tell what a hen has done within a month or 6 weeks. Several combinations of pigmentation are possible.

(a) A beak that is yellow part of the way out from the corner of the mouth and light beyond to the tip (*F*, Fig. 163) shows that the hen laid enough to bleach the beak entirely but stopped laying recently.

(b) A beak that is light part way out and yellow the rest of the way (*C*, Fig. 163) indicates that the bird has been laying after a long rest period.

(c) A band of yellow around the beak, with light color at the tip and near the base (*D*, Fig. 163) shows that the hen has had a period of rest or a vacation recently.

(d) A band of light color, with yellow at the tip and at the base, shows that the bird began laying after a long rest, but has recently gone out of production.

Conditions affecting pigmentation. The kind of feed given influences the condition of pigmentation. This fact must always be taken into consideration. Birds on grass range, or those fed a large amount of yellow corn, bleach out more slowly than those kept on bare ground or given feeds which contain small amounts of pigment, such as white corn, buckwheat, and skim milk.

Thickness of skin affects pigmentation. A heavy, coarse skin bleaches out more slowly. The larger bird usually bleaches more slowly than the smaller bird.

The vitality of the bird is a factor. If ill, a hen frequently has little or no color. In this instance the absence of pigment is due to a failure to make use of pigment rather than to having laid it out. A strong, deep color is an indication of vigor. A naturally pale individual is less likely to have the laying persistency needed by a high-producing bird.

Molt. Molting is the act or process of shedding and renewing feathers. Hens usually molt in the following order: neck, breast, body, tail, and wing. Pinfeathers usually denote a vacation or at least a possible slackening in production.

Birds inherit the tendency to shed their plumage annually. An early molter, under normal conditions, is a poor layer. A late molter, under normal conditions, is a good layer.

Hens seldom lay and shed feathers at the same time. A high-producing bird may, for a time, molt and lay simultaneously, but usually is holding her body weight or may even be gaining in weight, sheds more rapidly, and is declining in production when molting begins. When her secondary wing feathers and tail feathers commence to drop, it is a sign that she is nearly or quite through laying. The fact that a hen sheds rapidly, though early, stamps her as being better than the early molter that sheds slowly.

Molting and ceasing to lay indicate that a bird's physical condition is below normal. Presumably, a hen does not stop laying because she molts, but rather molts or stops laying because her physical condition is such that she cannot support egg production and continued nourishment of the feathers.

Whether the cessation of production or the shedding of the plumage occurs first depends, probably, upon the inherited tendency and the physical condition of the bird. If the bird has an inherited tendency to high production, molting probably will precede cessation of production. If the bird has an abundance of vitality and an inherited tendency to low production, a cessation of production is likely to precede molting. The body of the bird follows the line of least resistance.

Improper rations, irregularity of feeding, low vitality, poor housing, and an inherited tendency to low production are conditions which may cause birds to molt before the normal time. Proper foods for egg production and growth, desirable environment, stimulation by artificial light, and an inherited tendency to high production are likely to aid the birds to continue production and consequently to postpone molting beyond the normal period.

Flocks of layers possessing the inheritance of remarkably high egg production will contain many individuals which, under desirable management, continue to lay 15 to 18 months with little if any evidence of new feather growth. The persistency of flocks today is vastly improved over that of a generation ago.

Chicks may be purchased or hatched the year around in many parts of the United States, a phenomenon practically unheard-of a few years ago. The laying year may be longer or shorter, depending on the date of hatch. Birds hatched during the spring months start laying in 6 to 7 months and cease to lay a year or

so from that time. Those hatched in the preceding November or December start laying in 5 to 6 months and may cease about the same time as the flock hatched later. Hence, the birds hatched earlier have a longer period in which to lay. In general, the approach to the second winter after hatching is likely to be the end of the first laying year. Hens continuing to lay until that time and then molting are late molters. Many will not stop laying and molt even then. Birds ceasing to lay and molting earlier may be early or medium molters.

When a part of the flock is to be held for a second year of market egg production, the late layers or late and medium molters are the ones from which selections are made. All others may be disposed of. In general, the longer birds lay, the higher the production in their first laying year.

Early molter. The early molter shows that she has a shorter laying period than the late molter. She probably started late to produce eggs and lacks the vitality, laying capacity, or inherited tendency to continue in production.

The very early molter sheds and grows feathers so gradually that a person may not observe the process unless the bird is handled. She is not only very slow in molting, but as a rule she is very slow in production, having a shorter laying period and laying fewer eggs per week than the late molter.

If kept, the early molter seldom completes her molt in less than 3 or 4 months. She then rests and frequently does not get back into production any sooner than, and generally not so soon as, the hen that does not start to molt until several months later. In brief, she takes a longer vacation and should be culled when she ceases to lay.

Medium molters, compared to the balance of the flock, may be culled or kept for a second year of production, depending on the poultryman's needs, housing space, management plan, and the like. Such birds may molt fairly rapidly or slowly, depending on their length of laying period.

Late molters may drop feathers rapidly, and in a short time the plumage appears rough. There may be a few old feathers clinging to the bird, and her body will soon be covered with pinfeathers. It is seldom that any except the finest hens are seen in this ragged condition. While molting, the late molter is quite timid and dislikes to be handled. This is due to the active circulation and sensitive nerve development in the feather follicles while new plumage

is being grown. At this time the slightest touch hurts the bird.

The feathers grow in rapidly, so that the molt is over and the bird is ready for a second year of production as soon as the early molters would be if kept. Many medium or late molting birds laying a calendar year or longer will, after given a proper rest period, lay well during a second laying year.

Illumination after 5 weeks of non-production is advantageous if birds are beld as second-year layers. (See page 154.)

The wing molt—primaries. Because the wing primaries are molted in a certain definite order, they show how long it is since the bird stopped laying. This frequently proves valuable as a check upon the pigmentation of the beak and shanks, or as a factor by itself.

Each wing usually has 10 primaries (Fig. 165). Leghorns nearly always have 10, but the heavy varieties occasionally have 11. Very rarely, 9 are found.

Order of shedding wing primaries. The primary next to the axial is the first one dropped (Fig. 165, feather No. 1).

It seems a precaution of nature that the wing, to be used if needed as a means of escape, should never be without feathers. As a result, these quills are shed in regular order, about 2 weeks apart in the case of an early molter. Since the new quills start to grow immediately and it requires 6 weeks for one to grow to its full size, it will be seen, on an early molter, that when the fourth feather is shed a new full-grown feather will be in the place of the first one shed (Fig. 166).

Assuming that the hen stopped laying when the first quill was dropped, by allowing 6 weeks for the first feather if full-grown and 2 weeks for each additional full-grown feather, we can arrive at the approximate date when the hen stopped laying. Thus, the first 2 feathers new and full-grown show an 8 weeks' molt; 3 feathers complete, a 10 weeks' molt; 4 feathers, a 12 weeks' molt; and so on (see Fig. 166). Counting in this manner for the 10 feathers, we find that 24 weeks are required to complete the molt. This, however, presumably does not occur except in rare instances



FIG. 164. Characteristic appearance of a late molter growing feathers rapidly.



FIG. 165. *Left:* Note the ten primary feathers on the outer part of the wing. The short feather *A* between the primaries and secondaries is the axial feather. *Right:* The third feather from the axial feather is not full grown, denoting that three primaries were shed but that molting ceased at that point, perhaps at the time a resumption of laying occurred. Cornell University.

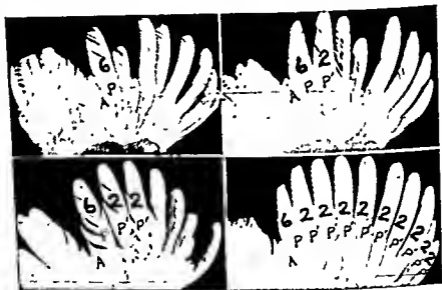


FIG. 166 Egg production indicated by the length of time of molting as determined by the shedding of the primary feathers. It takes about 6 weeks to renew completely the primary feather *P* next to the axial feather *A*, and an additional two weeks for each subsequent primary feather *P'*. Photographs taken on December 4, Cornell University.

Upper Left: A 6-week molt. (Primary feather next to axial feather renewed.) Estimated date stopped laying, October 23. Second year record, 186 eggs. *Upper Right:* An 8-week molt. (Two feathers completely renewed.) Estimated date stopped laying, October 9. Second year record, 164 eggs. *Lower Left:* A 10-week molt. (Three feathers completely renewed.) Estimated date stopped laying, September 25. Second year record, 121 eggs. *Lower Right:* A 24-week molt. (Ten feathers completely renewed.) Estimated date stopped laying, June 21. Second year record, 75 eggs.

and in the case of birds whose vitality and production are very low.

The late molter may drop 2, 3, or even 4 primaries at about the same time, so rapidly does she molt. In this case, all the feathers dropped at the same time should be counted as one feather.

If a hen drops out of production during the summer because of adverse conditions, she often drops one or more primaries, then stops molting and resumes production. This is known as a "vacation" molt, not a regular molt (Fig. 165, *right*). Fortunately, when she goes into the regular annual molt, she will drop the next feather in sequence and molt the remaining primaries in regular order. Then she may start back with the primary next to the axial feather and molt again those which had been renewed during her vacation molt.

When a break in the lengths of the primaries is noted, we know that the bird has taken a rest period. If the vacation occurred recently, it can be verified by the appearance of the beak. If all the feathers of this vacation molt are full grown, it is not possible to tell just when the hen took the rest.

The molt, therefore, assists in determining the length of laying period by showing when the bird stopped laying.

Wing molt—secondaries. Marble * reported the following order of dropping secondary feathers, counting from the axial feather toward the body (Fig. 167):

11, 12, 13, 14, 10, 2, 3, 4, 5, 6, 7, 8, 9, 1

Secondaries may be used as an aid in determining persistency. as birds are through or nearly so before the secondaries are dropped. All birds may be divided into two groups: first, those that continue to lay after starting to molt, and second, those that cease to lay when starting to molt. During 4 weeks after molting commences, these two groups may be expected to shed primaries and secondaries at the following rate:

	Primary Feathers	Secondary Feathers
Birds molting while laying	2.1	0.45
Birds molting and not laying	4.2	6.6

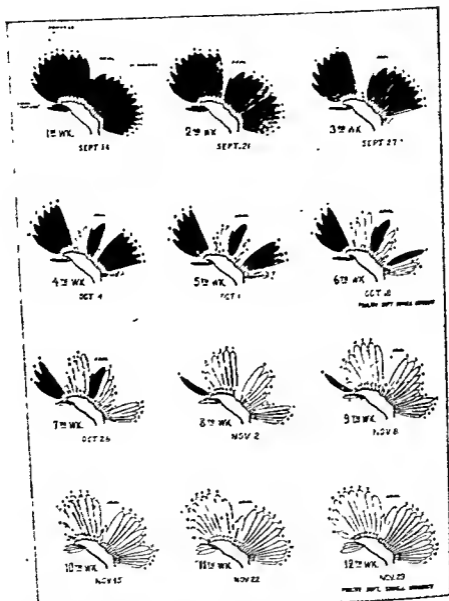


FIG. 167. The weekly changes in a normal wing molt. The primary feathers on the left are separated by the axial feather from the secondary feathers on the right in each of the twelve illustrations. The old feathers are shown in black and the new feathers in white. Cornell University.

Condition of the comb, vent, and abdomen. The *comb* is a secondary sexual character. It tells what is going on in the ovary. It indicates the hen's reproductive condition, and enables one to judge whether she is coming into or going out of production, or is laying. If the comb is dry, hard, and scaly, the hen may still be laying but she will soon stop.

If the hen has been out of laying but the ovaries are expanded and she is coming back into production, the comb indicates the fact. It begins to swell; the blood rushes to the tips of the points, and they become hot, soft, waxy, brighter in color, and full. The white scale on the comb breaks apart and pieces of the red comb show through.

The comb is reddest and warmest just before laying commences. As soon as laying starts, the comb gradually cools and becomes somewhat lighter in color.

The vent. When a hen is laying heavily, the vent is greatly stretched during the expulsion of the egg. It is therefore much larger than when she is not in laying condition.

A hen laying eggs is much like a cow about to give birth to a calf, in that the vagina of the cow, or vent in the case of the hen, enlarges and the bones and muscular tissues in the immediate section spread to allow easy passage of the young, or the egg. The hen is in a continuous state of reproduction, i.e., of pregnancy, while in laying condition, and it is because of this that the large, moist, dilated, and oblong vent is found on the best laying hens.

The abdomen. When the bird is laying heavily, the abdomen is much larger than at other times. The intestines and oviduct are expanded in the laying hen because they are distended and stretched by large quantities of food and by eggs.

When the bird is laying heavily, the reproductive and supporting organs occupy a considerable amount of room, and they obtain additional room by pushing down the rear of the keel and pushing out the skin of the abdomen. Hence the full, soft feeling of the abdomen of a layer and the great depth between the pubic bones and rear of the keel (Fig. 168).

When the bird stops laying, the intestines are not so full, because a smaller amount of feed and water is consumed, and the oviduct contracts because it has ceased to function. Hence, very little room is occupied by these organs. The pubic bones come closer together and become covered with fat, the rear of the keel springs back toward the pubic bones, and the skin lies in loose folds across



FIG. 168. *Left: Poor layer. Right: Good layer. Note greater depth, back to rear of keel, in the good layer. Cornell University.*

the abdomen. Later the skin of the abdomen may become shrunken and tightly drawn (Fig. 157).

Head. The head, both in the male and in the female, is the best single part of the body to judge past and possible future production and prepotency or ability to transmit high production. In it are shown pigmentation, body type, skin texture, laying condition, vigor, temperament, and expression.



A, rugged refined. Note symmetry of head when comb is straightened.



B, a rugged refined head, full of character.



C, a refined type



D, an overly refined type.

FIG 169 Examples of head differences in White Leghorns.



E. a crow head.



F. coarse head and sunken face. Not likely to make a high record.



G. a head typical of a non-producing bird.



H. a masculine-type head.

FIG. 169 (Continued)

By studying the heads of birds and simultaneously checking the results by means of other characters, one realizes that hens may be classified for egg production on the basis of the head with reasonable accuracy.

The following classifications, arranged in the order of best to poorest producers, are helpful in judging heads (Fig. 169).

Refined group

Rugged refined
Refined
Overly refined

Unrefined group

Crowhead
Coarse or beefy
Phlegmatic
Masculine

Body type. The type of a bird's body indicates her capacity as a producer rather than her immediate laying activity. The best birds, layers and breeders, must have a desirable body type, but not all birds having this are the best layers and breeders. The right body type must include in the make-up of the hen the urge to lay or the inherited tendency to high production. Body type, therefore, must be carefully checked with other conclusive characters indicating production. If the hen rates high in all, she is likely to be in the rugged refined or refined class.

The measurements checked are: (1) *heart girth*, for ample room in the heart and lung section; (2) *depth* from back to keel, indicating depth in heart section and greater depth in the abdominal region, combined with width through the *pelvic girdle* (page 419) where swollen oviduct and its egg and the full intestines must not be restricted (this measurement will be greater in the laying bird than when she is not laying); (3) *back width*, length, and straightness, for room to supplement depth and heart girth; (4) *keel*, whose length supports or fails to support the full abdomen (a long keel prevents the abdomen from sagging and thus interfering with digestion and health). (See Fig. 170.)

5. Exceptions

Occasionally, when studying external characteristics and estimating egg production of hens against trapnest records, a discrepancy occurs. In the past, part of this has been charged to floor eggs. When it was obvious that these eggs did not make up the difference, a more careful scrutiny of the bird concerned has not resulted in success. The only explanation has been, "She is an exception or a floor layer." Within recent years, workers at Cornell University and elsewhere have discovered hens which give the appearance of laying but produce no eggs to prove it. Such birds may have large red combs, if White Leghorns, and fairly well-bleached shanks, and may show no molt. The eyering, vent, and corners of the mouth may show excellent bleaching or slight cream, and the remainder of the beak may or may not contain yellow color.

Such birds would be missed in flashlight culling and would not be picked up when culling from the floor with hook or net. Even on handling the birds individually, many would be left as layers. Most birds of this sort would not be classed as heavy producers when the condition of abdominal fat and cream pigment are con-



(1) Measuring heart girth, width.

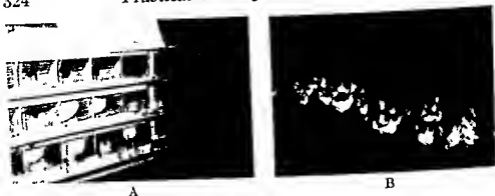


(3) Measuring back, width through the ischium or pelvic section.



(4) Measuring keel, length and straightness.

FIG. 170. Body-type measurements 1, 3, and 4 (see page 322).



A

B

FIG. 171. A. Daily scene in a trapnest pen of "exceptions" at Cornell University. An egg is a rare result. B. The "exceptions" on the floor. Gathered from a large number of layers, the individuals present a fair appearance.

sidered, but might be classed as medium to good birds. A few might be classed excellent.

Such birds may go on the nest day after day without laying eggs. A few lay now and then. Table 25 shows some typical examples of the nesting habits.

Table 25. Nesting Habits of Exceptions¹

Bird	Days of Month Found on Nest ²																Times Nested	Eggs Laid
No. 1	6	8	9	10	11	13	14	15	...	20	21	24	28	27	28	29	15	0
No. 2	6	7	8	9	10	12	14	15		20	21	23	24	25	26	28	16	0
No. 3	8	9	10	11	12	14	15			20	21	22	23	25	26	27	16	6
Days No. 3 laid	1					1	1			1					1	1		

¹ R. K. Cole and F. B. Hutt, "Normal Ovulation in Nonlaying Hens," *Poultry Sci.*, May 1953, p. 481.

² May 1954. Trapping did not occur on the 2nd-5th, 16th-19th, 30th, and 31st, inclusive.

Explanations of these conditions are not at this writing satisfactory. In some instances autopsy has shown irregularities in the oviduct. The ovary produces and releases yolks or ova which, not being picked up in the body cavity, are absorbed by the body, thus accounting for the heavier layer of fat just beneath the skin in the abdomen. Why the pigment is not replaced in the body, thus preventing bleaching, is not clearly known. Also, why the bird nests when there is no egg in the oviduct is perplexing and leads to the possibility of correlation between factors inducing ovulation and nesting desire.

Records indicate that nesting but nonlaying birds among White Leghorns range from 0.3 to 2.9 per cent.

6. Egg quality

The ultimate objective is the egg for consumption or that which the egg is capable of producing. Only those hens which produce eggs having desirable size, shape, color, and interior quality for the variety should be retained in the breeding pen. In many flocks there is vast room for improvement in egg quality. Size, shape of egg, color of shell, and interior quality, including blood spots, appear to be inherited from both females and males.

All eggs produced by any one hen tend to be similar in these characters, although they may vary somewhat. Trapnesting permits one to observe these characters of the eggs laid by each hen. An average of these characters in eggs laid by any hen gives a better idea of the type of egg the resulting pullet will lay than does the selection of eggs only at incubation time. Eggs produced by pullets after 6 months of laying are reasonably close to the average size for the year.

The pedigree breeder of the future may need to know not only the number of eggs and the exterior quality, but the interior quality of the eggs produced at various seasonal periods of the year as well.

7. Season of laying as an indication of egg production

Table 26, prepared by Professor James E. Rice many years ago, gives the results obtained with a group of fowls in a study of early sexual maturity or precocity and persistency.* It is included here for two purposes: first, to illustrate the relation to production, then and very likely for some time to come, of precocity, persistency, and length of laying period; and second, the tremendous change in the laying ability of the domestic fowl then and now. The underlying principle of laying performance is as true today as it was then.

To simplify the study, precocity is indicated by banding the pullets on the left shank with bands colored to represent the age at which each pullet started to lay. Persistency is indicated by banding on the right shank at the end of the laying year with bands colored to represent the approximate date the pullets ceased to lay. (See Table 27.)

* Cornell University data, 1916.

Table 26. Season of Laying as an Indication of Egg Production
Results of Early Sexual Maturity (Precocity) and Persistency in 166 Birds
Hatched in April and May 1916 at Cornell University

Laid 1st Egg	Leg Band, Left Shank	Number of Birds	Ceased Laying	Leg Band, Right Shank	Number of Birds	Production 1st Year	Production 2nd Year	Production 3rd Year	Average
Before 6 months	Blue	4	Layers, before September Breeders, after November 1 Group average	Yellow Blue	3 1 4	154.33 230.00 174.25	132.33 146.00 135.75	114.33 163.00 126.50	133.07 179.50 145.50
Between 6 and 7 months	Red	71	Culls, before September Layers, during September Breeders, during October Breeders, after November 1 Group average	Yellow Green Red Blue	22 18 22 9 71	124.45 154.44 176.01 193.22 157.01	110.01 138.78 139.80 164.33 153.72	99.23 117.44 122.77 142.33 116.60	111.33 136.80 146.24 167.29 135.78
Between 7 and 8 months	Green	50	Culls, before September Layers, during September Breeders, during October Breeders, after November 1 Group average	Yellow Green Red Blue	19 15 11 5 50	114.79 150.73 100.18 161.20 140.20	98.53 128.00 112.82 139.80 121.30	87.93 115.33 130.36 122.40 108.94	100.42 131.30 141.45 141.13 123.46
Between 8 and 9 months	Yellow	22	Culls, before September Layers, during October Layers, after November 1 Group average	Yellow Red Blue	18 3 1 22	98.06 146.67 173.00 108.09	110.33 130.33 160.00 121.04	106.78 119.00 113.00 108.73	107.06 131.00 148.67 112.62
After 9 months	No band	19	Culls, before September Culls, during September Layers, during October Layers, after November 1 Group average	Yellow Green Red Blue	10 6 2 1 19	70.20 81.83 115.50 151.00 86.03	91.50 122.67 110.00 142.00 106.58	75.60 110.00 110.00 133.00 93.10	81.10 101.83 113.83 142.00 95.24

Table 27. Plan for Banding

PRECOCITY		PERSISTENCY	
Banded on <i>Left</i> Shank		Banded on <i>Right</i> Shank	
Age at banding	Color of band	Date of banding	Color of band
6 months	Blue	Before September	Yellow
7 months	Red	During September	Green
8 months	Green	During October	Red
9 months	Yellow	After November	Blue

Table 26 should be studied first for precocity, then for persistency, and finally for the two factors combined.

First check precocity. The average egg production for each of the five groups, based on their age at first egg, is 174, 157, 140, 108, and 86. Those starting before 6 months averaged most eggs, and those beginning to lay after 9 months averaged 86. Each group averaged less than the preceding group in a rating based on precocity.

The most persistent birds are those laying after November. In the first group is one such bird that laid 230 eggs. She also was one of the first to start; therefore, whether the rating was based on *persistency* or *precocity*, her superiority would have been recognized.

In the second group, 9 birds were laying after November. These averaged 195. In the third group, 5 averaged 161. In the fourth group, one laid 173; and in the last group, one laid 151.

All these most persistent birds were good layers. The birds banded with red, those ceasing to lay in October, were better in nearly every case than those banded with green, which stopped laying a month earlier.

If all birds ceasing to lay before September 1 had been culled, only 3 good birds (first group) would have been culled. This speaks well for *persistency*.

If all birds that started to lay before they were 9 months old had been retained as pullets, there would have been a number of rather poor layers. This indicates that precocity is a less reliable guide than persistency.

A combination of the two, however, gives the correct length of laying period and provides a fairly accurate means of culling.

References

Write your own state college of agriculture for pamphlets and guides to principles of selecting layers and breeders.

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Selecting and Mating the Breeders *

To make the useful more beautiful and the beautiful more useful is the highest aim of the science and art of poultry breeding.

Breeding is the science and art of mating animals or plants with the expectation of securing in the offspring definite results in the development of certain specific characters. The forces that produce these qualities exist in the body of the individual and are increased or decreased by selection and breeding.

Improvement of poultry is brought about by the action of two great natural forces: environment, which includes food, surroundings, and climate; and selection and mating, which include both natural selection and mating and the purposeful selection of poultry practiced by man.

Natural selection and mating are the actions of the slow, uninterrupted forces of nature. They influence and modify all animal and plant life and have given rise to the phrase "survival of the fittest." Nature secures a high type of vigor and perpetuates the race, because under natural conditions only the strongest can survive. Inbreeding is not so likely to be detrimental in the wild state as it is under domestication, because only the strong live; but the process used by nature is too slow and does not accomplish all the results desired for the purposes of man.

Under the conditions created by man, most of the individuals generally have a chance to live, and man must select those best suited to his needs and ideals.

Selection, as discussed in the previous chapter, can bring about improvement in production or meat type, but after a period of time a limit is reached. Environmental conditions are likely to have improved also, and the combination may sometimes result in

* For a discussion of the genetics of poultry breeding, the reader is referred to *Poultry Breeding* by M. A. Jull, 3rd ed., John Wiley & Sons, New York, 1952.

startling advance for a period. Because individuals vary not only in their own abilities but also in their power to transmit these qualities to others (prepotency), it remains for those interested in further improvement to select breeders on the basis of the performance of relatives or the results of the breeder's own progeny.

Operations:

1. Deciding when to mate the breeders.
2. Deciding the number of hens per male.
3. Eliminating the influence of a previous mating with a different male.
4. Studying methods of mating.
5. Selecting on the basis of the performance of ancestors, brothers, sisters, and progeny.
6. Securing fertility and hatchability.
7. Pedigree-hatching.
8. Selecting breeding males.
9. Principles in controlling inheritance.

1. Deciding when to mate the breeders

The birds should be mated at least 2 and preferably 3 weeks before eggs are to be saved, although the eggs may be fertile after a particularly active male has been with a small flock 3 or 4 days, provided all environmental conditions are favorable. Eggs should not be saved more than 10 days before incubating. Breeders should be mated 6 to 8 weeks before the chicks are expected.

2. Deciding the number of hens per male

For Leghorns, 1 male to about 20 females should be allowed. Eggs have shown high fertility where 1 male to 30 or 40 females has been used. For American varieties, allow 1 male to about 15 females. For Asiatic varieties, allow 1 male to about 10 females.

In order to ensure satisfactory fertility early in the season, it is necessary to use a smaller number of females than would be required if hatching were done later in the season.

3. Eliminating the influence of a previous mating with a different male

If it is desired to change males during the breeding season and have no influence of the former male in the progeny, at least 2 weeks should elapse from the time the first male is removed until eggs are saved from the mating with the second male.

4. Studying methods of mating

There are several methods by which the selected breeders may be mated.

Large-flock mating. Most commercial flocks are bred by the large-flock method. A number of hens and males are placed in the pens together, sometimes as many as several hundred birds. Practically no serious fighting takes place if more than two males are in the flock and they have sufficient floor space and range. Chicks cannot be pedigreed, as the male parentage cannot be known. Carefully selected females mated with males from desirable blood lines have given excellent results in the laying ability of the pullets. This method provides many hatching eggs at a very much less expense for labor and housing.

Small-flock or pen mating is used when a few choice individuals are mated with a single sire. The parentage of each chick is known since, by trapping, the identity of the dam is known.

This method permits line breeding and progeny testing, and reaches its best possibilities on a breeding farm using several such pens.

Alternating males. Males occasionally mate with certain hens to the exclusion of the others, with the result that eggs from other hens in the flock are not fertile. If signs of preferential mating are noted, or if the flock is so large that 1 male cannot be expected to fertilize the eggs satisfactorily, or if one is not pedigreeding, 2 males may be used alternately. The changes should be made on alternate days, or in some cases about twice a week, and the male not in use should be rested in a coop. This eliminates all interference and fighting.

Stud mating. In large flocks it may be desired to mate certain males with certain females while the latter are running together. This may be done by trapnesting and stud mating. The males are kept in coops, about $2\frac{1}{2}$ by 3 feet and 3 feet high, 1 male to each coop. A record is kept of the band numbers of the hens to be mated with a particular male. When a hen is removed from the trapnest, she is placed in the coop with the male with which she is to be mated, and released at the next trapping. To help guard against error, the males and females to be mated together may have leg bands of the same color.

If the proper records are kept, the parents of each chick will be known.

5. Selecting on the basis of the performance of ancestors, brothers, sisters, and progeny

High producers do not always beget high producers. Rather, the son of a hen which is one of several in a single family of high producers has a better chance of being prepotent than if the production of the dam's sisters is only medium, even though his dam is a high producer. The same applies to the female.

The performance of ancestors and brothers and sisters increases the possibility of a similar performance by the individual.

However, the highest type of breeding work, and the one which promises the most rapid and complete success, is reached when the worth of a bird as a breeder is judged by the way the progeny perform. This requires the progeny test.

The value of the progeny test is at once apparent, as by it both males and females with high prepotency for producing desirable or undesirable qualities are discovered. More money value is represented in this quality of prepotency than in any other single quality of a bird.

To accomplish this test, a bird that has passed the five important characters (page 306) is mated. The fertility and hatchability of eggs and the viability of the chicks are checked. After the rearing season, the progeny of promising families are housed and records of their performance kept.

6. Securing fertility and hatchability

Perfect incubation would be obtained if every egg incubated hatched into a strong chick capable of developing into a full-grown bird. Much depends on the health and physical condition of the breeders. Hens, if used, should be completely rested and recuperated physically before the breeding season. Every egg that is set but not hatched is a loss in several ways:

- (1) The egg itself is changed from a marketable to an unmarketable product.
- (2) It occupies incubation space, which might have been used to hatch a chick.
- (3) It requires the attendant's time and care, and expense for fuel.
- (4) There is delay in obtaining the expected number of chicks, owing to the necessity of replacement in a later hatch if the loss is serious.

Two factors are of primary importance in the effort to secure good hatches: (a) fertility, and (b) hatchability.

Fertility. Infertile eggs may be the fault of either the hen or the male. If the fault is due to preferential mating on the part of the male, it will be necessary to mate the hen with another male. Closely confining males, as in stud-mating coops, for several weeks may affect their physical condition and thus lower fertility.

Well selected stock, carefully housed and fed, should aid fertility.

Gallantry may cause males to eat too little. Special grain feeders 18 inches up and on the wall may solve that problem for males.

Climate affects the mating of poultry to a marked degree. Matings are much less frequent during very cold weather. Freezing of the comb or wattles may affect fertility. To protect males, *dubbing* is rapidly becoming general practice. At 8 to 12 weeks of age the comb and wattles are cut off with shears. There is no need to check bleeding. Pullets in laying batteries have been dubbed and the effects studied. Observations made on April-hatched birds during 1954-1955 indicated that dubbed pullets laid more eggs, consumed less feed, and had fewer pauses. Precocity and persistency seemed unaffected, and differences in mortality were slight.*

Fertility is higher among hens laying eggs in cycles of more than 3. Hens copulate more frequently and have longer duration of fertility following insemination when ovulation rate is rapid. Highest fertility is obtained during periods of highest egg production.

Hatchability. Not all fertile eggs will hatch. Certain hens will show higher hatchability than others having similar treatment and care and showing similar fertility. Hatchability is thought by some to be inherited, but environmental conditions surrounding breeders and eggs may be more important.

Breeding, feeding, housing, egg size, care of eggs, or incubation may be responsible for the number of chicks which a hen may produce in any season. Close inbreeding usually results in lowered hatchability in succeeding generations.

Breeders should be in fine physical condition.

It does not follow that high production annually, or during the breeding season, necessarily results in less fertility and hatchability. On the contrary, the highest fertility and hatching quality should be found among the highest producers.

* G. T. Davis and D. C. Hutto, "Effects of Dubbing on White Leghorn Pullets," *Abstracts of Papers, Poultry Science Assoc.*, 44th Annual Meeting, Michigan State Univ., 1955, p. 15.

If eggs are fertile and hatch well after mating pens are made up, they are likely to do so throughout the hatching season, but not necessarily so. A hatchability of 85 per cent or better of fertile eggs is a workable standard for the individual hen.

7. Pedigree-hatching

In order to know the parentage of each chick, it is necessary to pedigree-hatch the eggs. For progeny testing this information must be obtained. It is essential if one aims to make the most definite and rapid progress in breeding for egg production. The following are some of the essentials for pedigree-hatching.

(1) Mark each breeding female and male (generally with a numbered leg band).

(2) Mate each group of females with a single male.

(3) Trapnest the birds.

(4) Record the matings, the number of each bird, her annual production, hatching record, fertility, and hatchability.

(5) Mark on the large end of each egg the pen number and the number of the hen, at the time the hen is removed from the trapnest.

Example: $\frac{1128 \text{ (Hen number)}}{15 \text{ (Pen number)}}$

(6) Before the eggs are placed in the incubator, arrange them systematically by hen numbers. Eggs from each hen must be grouped together so that they may be placed in the machine together and grouped on the incubator record sheet for quick reference.

(7) On the eighteenth day, place the eggs from each hen in separate pedigree baskets, in order that the chicks from each hen may be correctly identified and banded.

(8) Wing-band each chick with a special clinched or sealed and numbered wing band, and record properly so that, from the band number of each chick, its parentage can be quickly determined by referring to the incubator record sheet and the breeder's record.

(9) Record on the breeder's record the wing-band number of each chick in order, by families, from the first to the last chick banded in each season. Provide space in the records for entering during the season the growth rate, livability, sex, laying record, cause of death, and other information.

8. Selecting breeding males

Since the male mates with many hens, his influence is greater than one hen's. Much attention should be given, when possible, to the progeny of the male and each hen with which he is mated. This is called the *progeny test* (see page 332).

The ability of a male to transmit the production qualities desired cannot be seen by looking at him. A good male is likely to be vigorous, gallant, courageous, and free of defects and disqualifications. The head should be masculine, with well-developed comb,



FIG. 172. A high-quality White Leghorn production breeding male, age 4 years. Note the well-shaped comb; aggressive, active expression; strong head; and deep, rectangular body.

earlobes, and wattles. Comb points of a single comb should be wide at the base, blade low. If the bird has been dubbed, this character cannot be used.

The main difference in body type between males and females is found in the relative width and depth of the front and rear of the body of the high-production male. It has proportionately broader and deeper heart girth and not quite as much width and depth of body as the high-production female.

The body should be relatively deep in front, and as deep at the center. The rear is likely to be more shallow on a good male than on a good female.

The length of keel is important, the long, well-curved keel being more desirable.

The prepotency of a male is likely to be influenced through inheritance in accordance with the laying ability of his parents and his sisters.

9. Principles in controlling inheritance

The improvement of poultry through breeding depends on the sustaining hand of man. Progress is slow and laborious, and the pitfalls are many. One may mount the ladder of success, step by step, only to fall back to the starting point through one or more missteps.

The practices here discussed are variation, inbreeding, line-breeding (a special form of inbreeding), out-crossing, and crossbreeding.

Variation. Poultry, like all animals and plants, vary from each other. No two are exactly alike. Careful selection and mating will produce groups which to the casual eye appear very similar. However, individual examination will show external differences, and there are differences internally, such as prepotency, number of eggs laid, and the size, quality, hatchability, and color of eggs. Because of variation, the skilled breeder is able to improve in his strain the characters which he considers important. The breeder not only aims to improve each generation, but to produce individuals prepotent in those characters in which he wishes his strain to excel.

Inbreeding. The closest form of inbreeding is mating together closely related individuals, as brother and sister, father and daughter, or mother and son. Close inbreeding is used to secure uniformity in a character but cannot be practiced long in any blood line. Undesirable characters show up quickly. The failure of close inbreeding to produce desirable results each time may be due largely to man's inability to select the combinations of vigor required.

Research workers find that, in general, close inbreeding lowers production, vigor, hatchability, rate of growth, and fertility; retards sexual maturity; increases mortality; and shortens the length of laying period.

From this it will be inferred that close inbreeding is a dangerous practice for the average breeder; but this does not mean that out-crossing is necessary every few years. In fact, in flock matings where 100 or more hens are mated with several males and females are selected at random, the chance of dangers from closely inbred matings are remote.

The techniques for the development of *inbred lines* for use in the production of *hybrids* are explained in *Jull's Poultry Breeding*.

Line-breeding. Line-breeding is systematic inbreeding, and is designed to avoid the possible dangers arising from the miscel-

laneous mating of individuals which are too closely related. It is possible to line-breed systematically for many years, thus securing the advantages of breeding from similar blood lines but avoiding the danger of mating closely related individuals. It is the process of carrying along the blood of a desirable individual for several generations to produce inbred strains. The close inbreeding of brother and sister is avoided, but an outstanding male may be mated with his daughters and then with his granddaughters in the development of a desirable blood line.

Out-crossing or strain-crossing. Out-crossing consists in mating birds of the same variety but of different strains. It is occasionally resorted to when the breeder desires to introduce new blood.

A breeder desiring to improve his strain in some character will use a male of the strain he desires, and produce males for his flock. Such a male may be used in a line-breeding plan, or he may be discarded after a year or two.

When introducing blood of a different strain than that already in use on the farm, care should be taken to "test" by mating one or two pens and determining from the progeny whether the blood lines unite to produce the desired performance.

Fertility and vigor are likely to be increased in the first generation as a result of out-crossing. Continual out-crossing is to be discouraged, as much may be lost and little gained. It is usually better to avoid mixing the blood lines of several strains.

Top-crossing, using inbred males, is a new technique for breeding. It is explained in Jull.

Crossbreeding. Crossbreeding is the mating of individuals of different breeds or varieties. Crossing certain breeds enables one to determine the sex of chicks at hatching time. The advantages are high hatchability, early sex determination, reduced mortality, increased vigor, and desirable production. For many years a popular cross was the Red male on the Barred Rock female. The female chicks have black heads, and the male chicks show some white on their heads in about 95 per cent of the cases. The adult female resulting from this cross is black with reddish hackle, and was formerly in demand for egg production. The males are barred, and were in demand as broiler chicks.

The reverse cross, or the Barred Rock male on the Rhode Island Red or New Hampshire female, gave chicks which, as adults, were all barred. Sex could not be determined at hatching time by plumage differences. This cross was popular as broilers.

Recent research indicates that this barred cross pullet may lay better than the black cross pullet. However, other crosses are likely to prove more in demand.

Reciprocal recurrent selection is a shortcut in determining values of breeders somewhat similar to, but quicker than, the production of hybrids by inbreeding. (Explained in Jull.)

Reference

Bohren, B. B., G. D. Rapp, and R. B. Arvidson, "Increase in Pullet Egg Size as a Factor in Selection," *Bull.* 574, Purdue Univ., Lafayette, Ind., 1952.

Renewing the Flock

Operations:

1. Deciding when the flock should be renewed.
2. Deciding whether to buy or hatch chicks.
3. Deciding whether to buy sexed chicks.
4. Selecting the hen.
5. Choosing the incubator.
6. Locating the incubator.

General information:

1. Hatching once or several times during the year.
2. Types of incubators.

Operations

1. Deciding when the flock should be renewed

Points to consider are: (a) when space in the laying houses will be ready for the new pullets, (b) the hatching plan, (c) egg prices, (d) rearing conditions, and (e) breed and variety.

The flock of layers is likely to be about one-half of the original size at the end of the first laying year. A desirable practice is to move the remaining birds in April or May to temporary quarters or barracks and allow them to complete their laying year there. They will remain in barracks until sold, or until moved into winter quarters about November 1 to molt and start another year of laying. This releases the permanent quarters early in the summer, to be prepared for the new flock of pullets.

Convenience or other conditions may require that all chicks be secured at the same time, or in several lots during a certain season, or at different seasons of the year.

Highest egg prices for large eggs occur during the early fall. From May or June until October, egg prices usually advance.

Hence, one may desire to have pullets start laying during the spring and to hold the old birds in production as long as possible.

2. Deciding whether to buy or hatch chicks

Chicks of nearly any potential egg or meat quality can be purchased, either from the breeder, who hatches only from his own flock, or from the hatchery, which secures hatching eggs from co-operating flock owners. The economy and convenience of buying chicks have made the practice very popular.

The poultryman who has incubator space or who can select from his flock the quality of breeders he desires, and who enjoys this part of the enterprise, can produce chicks at the same or a lower price than he would have to pay for similar quality. A greater investment is needed, however, than if the chicks are purchased. Unless trained in poultry breeding, he assumes the risk of a poor hatch and possibly of lower quality.

3. Deciding whether to buy sexed chicks

If chicks are to be purchased, the problem of buying straight-run, sexed, or sex-linked chicks must be decided.

Straight-run chicks include cockerels and pullets.

Sexed chicks are separated into males and females at hatching time by examination of the vents by trained persons. Over 95 per cent accuracy is reached. The basis for figuring the price of sexed pullets is sometimes twice the straight-run price plus the cost of sexing. Chick sexers are paid $\frac{1}{2}$ to 1 cent per chick sexed.

Care should be taken not to overcrowd if sexed pullets are obtained. At 8 weeks or before, the sexed pullet flock should be given more room.

Sex-linked chicks are the result of certain variety or breed crosses. Their progeny can be sorted accurately into males or females by differences in color of plumage or other characteristics. Many crosses are desirable as layers or as meat birds, but are not desirable as future breeders.

4. Selecting the hen

If one is to hatch by natural methods, the choice of the hen is important. Select a hen in good health, of medium size and quiet disposition, and without feathered shanks. The ideal hen can be found best among American breeds, such as the Plymouth Rock, the Wyandotte, the Rhode Island Red, and the New Hampshire.

Very large hens, and those that are nervous and excitable, often break the eggs and sometimes injure the chicks by stepping on them. A ruffling of the feathers when approached, clucking, and use of the beak are signs of a sitter.

The incubator has replaced the hen in commercial poultry work.

5. Choosing the incubator

A knowledge of the principal types of incubators is necessary to enable the poultryman to choose the one best suited to his conditions. But the experience of personally known successful users should be considered before deciding finally which type of machine to buy.

If chicks are to be purchased, an incubator will not, of course, be needed. For a few hundred chicks, a small type of machine should do. When 1500 or more chicks are to be hatched, the operator may well consider one of the large-capacity machines. Comparative investment, available space, convenient size, labor and costs of operating, and possible future expansion should be considered.

When the business warrants selling chicks from one's own flock, or a hatchery business is contemplated, the large or mammoth machines are likely to prove best adapted.

6. Locating the incubator

Still-air machines need a room temperature of about 70 degrees F. The cooler the outside room is, the greater will be the difference in temperature between the top and the bottom of the eggs in the incubator. Poor hatchability may result from maintaining too low or too high temperatures in the incubator room. Under such conditions, the average incubating temperature within the egg will be either too low or too high, though the temperature reading on the thermometer is correct. Hence, the more even conditions found in a basement, cellar, or especially built incubator room are preferred.

Cabinet or forced-draft machines are less affected by room temperature than *still-air machines* because of more rapid air movement and more uniform temperature between top and bottom of the machine. Hence, rooms aboveground are more often used. To prevent fuel loss, and to provide comfortable conditions for the operator and chicks, these rooms should be well insulated when aboveground, and kept at 70 to 75 degrees F.

Directions should be obtained from the manufacturer of the

machine in which one is interested, and they should be followed carefully. Manufacturers of incubators are interested in having their machines give maximum favorable results. Material from several companies should provide a liberal education in proper environment.

General Information

1. Hatching once or several times during the year

The idea of hatching during the spring has so long prevailed that with some poultrymen it has become a custom not to be disputed. However, the increasing demand for chicks at other seasons, the introduction of better controlled incubators, and the newer knowledge of feeding and breeding for hatchability and growth have given rise to the practice of hatching the year around.

The hen and the native birds, which are forced to do their sitting at a time when food is abundant for both mother and young, work under different conditions from those of the modern poultryman. Through scientific discoveries, he has learned how to supply necessary feed ingredients to both old and young stock at times other than the spring season. Better knowledge of chick disease control has also helped to remove risks.

By using the records from one's own flock, a plan of the time for hatching or purchasing chicks may be formulated so that pullets will be ready to place in the laying houses one, two, or more times during the year, thus bringing the flock back to its original size. Less brooding equipment is needed as the number of hatches is increased, but other conflicting factors may be involved.

The successful hatcheryman will govern his season of hatching by the demand for chicks. The poultryman will be guided in his seasonal purchasing or hatching of chicks by:

(a) His business demands, whether broilers with 3 or 4 lots per year, or layers with the object of maintaining the laying flock.

(b) Most efficient use of building space.

(c) High production the year around with maximum production of large eggs during the period of highest prices.

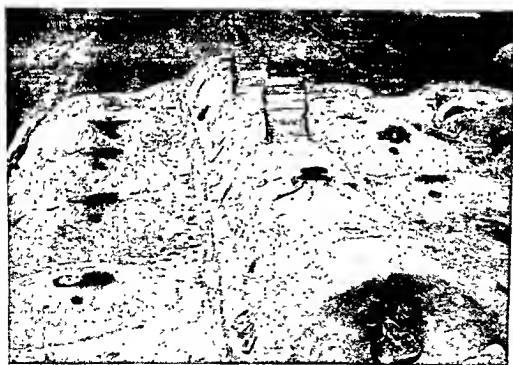
(d) Uniform distribution of labor.

Chicks secured once annually. The following assumptions are made when chicks are secured once annually:

(1) That the price for large eggs is the highest from June 1 to November 1.



A



B

FIG. 173. (Legend on page 344.)



C



D



E



F

FIG. 173. Egyptian and Chinese hatcheries have been in use for thousands of years. *A.* A "mahmil," or native Egyptian hatchery. *B.* Roof of the mahmil. Central rounded area is over an inside alleyway. On both sides are the roofs of ovens with hole and stone to regulate the outflow of air. Each oven holds 6000 hatching eggs. There are 11 ovens in this mahmil. *C.* The alleyway from which the ovens are serviced. *D.* Each oven has two levels for eggs. The lower, shown here, is at alleyway floor level. Through this large opening eggs enter the oven, are piled 3 to 4 eggs deep, and are left for 11 days. The opening is filled with straw or other material, opened during incubation only when greater air movement is necessary. Eggs are turned by rolling armfuls at one time. Note the caretaker's feet near the far side of the eggs. *E.* During the first 11 days smoldering straw fires burn on this level. Much smoke pre-



G



H

FIG. 173 (Continued)

vails. Note glistening carbon on walls. On the 12th day half of the eggs are moved to this waist-high shelf. The fire is extinguished. The eggs above and below have no further artificial heat. The caretaker descends to the floor level through this opening. *F.* Eggs are tested for temperature, infertiles, and live germs by holding against the eyelid. *G.* A hatch of "balidi," or native chicks, in an Egyptian hatching oven. *H.* As soon as the chicks are dry, they are placed in the alleyway for a day to harden, after which they are placed in baskets on the backs of donkeys and peddled to the natives.

(2) That brooding and overflow quarters, if the birds are confinement reared, are sufficient to hold growing pullets for 16 weeks, allowing 2 square feet per bird.

(3) That this space is sufficient as barracks for the remaining first-year laying birds.

(4) That an interchange of pullets and hens may be made on used litter. (Range-reared pullets may be left on range after the layers are moved to barracks, to permit removing all litter from the laying pens.)

The following *management procedure* would then be appropriate:

(1) Chicks are placed in brooders about December 1, allowing 1 square foot per bird to 8 weeks and 2 square feet to 16 weeks.

(2) In April, pullets are placed in permanent laying quarters.

(3) The hens are moved to the space vacated by pullets and left there, in barracks (see page 45).

(4) About November 1 the previous 2-year hens, now completing their second production year, are disposed of.

(5) About November 1, the best $\frac{1}{3}$ to $\frac{2}{3}$ of the hen flock (now in barracks) are placed in the quarters thus provided (4), for their second production year.

(6) These hens (5) are molted through November and December.

The *advantages* of such a system of management are:

(1) Labor of brooding and rearing is done after heaviest production has eased off.

(2) Pullets are at maximum production and laying many large eggs during the period of highest prices.

(3) Barracks hens and 2-year hens are laying large eggs through the summer and fall months.

(4) All labor is being used during these months to handle and market the largest number of eggs produced during the year.

(5) One month, November, is available to prepare brooding quarters for chicks by December 1. (See page 46.)

Other management plans are explained in *The Economics of Poultry Management* by H. E. Botsford, published by John Wiley & Sons.

2. Types of incubators

Incubators can be roughly classified according to heating method, as:

(a) Radiation from hot-water pipes in the egg chamber.

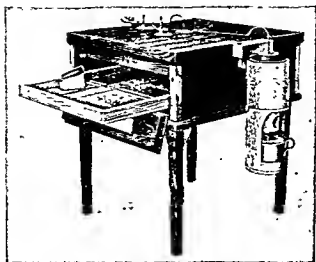


FIG. 174. A hot-water incubator, showing heater. The heated water enters the machine through pipes near the top of the machine. From Newtown Incubator Co.

(b) Warm-air infusion, that is, previously warmed air forced directly into the egg chamber.

(c) Warm-air diffusion, that is, air forced through heated fins or diaphragms located within the machine.

(d) Forced-draft, where the heat is supplied by electric heating elements and the air is circulated or agitated by means of fans or paddles.

Small incubators. These can be divided also into moisture and nonmoisture types. One moisture type is equipped with a tray of sand in the bottom, which is kept wet. The moisture prevents excessive evaporation of the eggs while the air is continually changing within the machine. The nonmoisture type reheats and redistributes the air, thus reducing the change of air and preventing excessive drying of the eggs.



FIG. 175. A regulating device and four-bar thermostat. 1. Connecting rod; 2. adjusting nut; 3. counterpoise arm; 4. counterpoise weight; 5. regulator arm; 6. thermostat; 7. thermostat supporting rod; 8. knife edge casting; 9. disc.

Incubators are available having capacities of 50 to several hundred eggs.

Heat may be supplied by kero-sene, gas, or electricity. In kero-sene- and gas-heated incubators, as the heat expands the thermostat, the latter pulls down on the connecting rod, raises the disk, and thus allows the surplus heat to escape. As the amount of heat decreases, the thermostat contracts, allowing the disk to drop down on the heater, thus directing more heat into the machine.



Fig. 176. A modern hatchery in the United States, using mammoth incubators.

In electric incubators the current is turned on or off, as the case may be, thus supplying heat only when needed.

Mammoth incubators. The small incubator was the stepping-stone from hen-hatching to the sectional machines and then to the cabinet machines. The coming of mammoth incubators not only enabled the breeder to incubate several thousand eggs with greater economy and to diversify his business by selling baby chicks, but it gave rise to the important hatchery industry.

The *cabinet* type is a compact room (Fig. 177). Eggs are placed in trays from the top to the bottom of the machine. The temperature is evenly distributed through the entire machine by either paddles or fans; hence, the name "forced-draft" machines. The machines can be placed in almost any part of the room that is most

convenient for the operator. It is easier to heat one large room, such as the cabinet machine, than many small rooms, such as the sectional machine; and there is less wall area, hence less exposed area per given number of eggs.

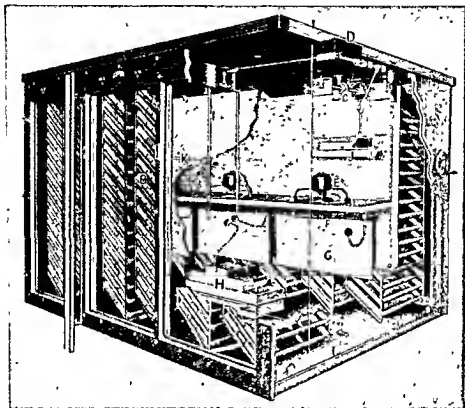


FIG. 177. A mammoth forced-draft type incubator (setting unit). Separate hatching units required. *A*, Careful insulation; *B*, 15 egg trays in each stack; *C*, egg turning apparatus; *D*, fixed ventilators in top and end; *E*, ball-bearing circular fans push the air to the floor and up through the egg trays; *F*, low-intensity, open-coil type electric heaters; *G*, baffle plates for dividing and directing the air; *H*, automatic humidifier; *I*, double long-tube control and safety thermostats; *J*, humidity control; *K*, long-stem temperature thermometer and special wet-bulb thermometer to be read outside the machine. Courtesy Buck-eye Incubator Co.

Cabinet-type machines are heated with coal, oil, gas, or electricity. When electric current is dependable, it is most often used.

Most of the modern forced-draft cabinet-type incubators provide humidity control by spraying water into the machines, or by passing humidified air into the machines and determining relative humidity by the use of wet-bulb hygrometers.

Separate hatcher. This feature provides units for incubation through the eighteenth day, and separate units for hatching, thus permitting a slightly lower temperature from the eighteenth day. It also permits the two compartments to be fumigated or disinfected

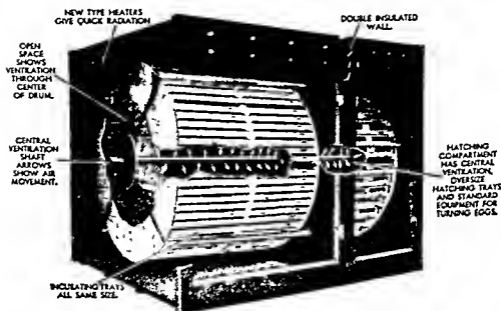


FIG. 178. Petersime Hatchibator. Open view of the Model 20 Petersime Hatchibator. This type provides a breathing air movement. The air entering the central ventilation shaft is stirred by the rotation of the four-bladed reel as it moves slowly around the egg drum, mixing moisture with the warm air and equalizing the temperature. As the blades move down on one side, other blades move up on the other side. The greatest air pressure is on the lower side of the one blade and on the top side of the other. This causes a push-pull air movement through the entire compartment. Courtesy of The Petersime Incubator Co

separately. In the sectional-type machine, the separate hatching compartment is less necessary since no other eggs are involved at hatching time. With a machine in which all stages of incubation, including hatching, are in one compartment, it is necessary to fumigate and disinfect the machine while all the stages of incubation and hatching are in progress.

There are many fine examples of both types of mammoth incubators.

Community Survey

1. Are eggs incubated the year around or seasonally in your locality?
2. What are the reasons for this situation?
3. What makes of incubators are in use nearby?
4. When are eggs tested? Are any eggs removed before hatching?
5. Are any poultrymen starting chicks at other than the spring season?
6. If so, when?
7. Why are they doing this?
8. Explain how the hatching season fits in with the management plan on a successful farm in your locality.
9. Ask one or more poultrymen how they figure the number of pullets they will need in a year.
10. What percentage of the poultrymen hatch their own chicks?
11. What percentage of the poultrymen buy their chicks?
12. Do any of the poultrymen buy sexed chicks? Why do they get them?
13. Are crossbred chickens grown?
14. If crossbred chickens are grown, explain the reasons.
15. Visit the owner of a mammoth incubator containing eggs. As he cares for machine and eggs, record each process in order. When this is finished, ask for and record any changes from what he has just done, and when they occur throughout the hatch.
16. Repeat for the other kinds of incubators.

Hatching the Eggs

The process of incubation—by which in the space of 3 weeks a microscopic germ is changed into a downy chick capable of walking, eating, and expressing its needs by its voice and actions—seems nearly magical. With such rapid development and change within the egg (see Chapter 24), great care must be exercised to provide correct conditions if a good percentage of strong chicks is to be hatched. No detail should be overlooked in giving the egg every chance to hatch and each chick a chance to live, since upon their ability to do this may rest the success or failure of the poultry enterprise.

Operations:

1. Selecting hatching eggs.
 2. Caring for hatching eggs.
 3. Testing the thermometer.
 4. Preparing the small incubator.
 5. Preparing the mammoth incubator.
 6. Starting the hatch.
 7. Maintaining the proper temperature.
 8. Maintaining the proper humidity.
 9. Turning the eggs.
 10. Ventilating the machine.
 11. Cooling the eggs.
 12. Testing the eggs.
 13. Taking off the hatch.
 14. Cleaning and disinfecting.
 15. Hatching with hens
1. Selecting hatching eggs

Each egg is a potential chick. We desire it to be fertile, and to hatch a chick that will live and grow into a desirable meat bird or into a pullet that will produce the right kind of market eggs. Breed-

ing plays an important part. The breeders have laid the eggs, our job is to select the best eggs we can.

Select eggs that are uniform in size, shape, and color, that have strong shells, and that weigh about 2 ounces each or 24 ounces to the dozen for hens, or $1\frac{1}{12}$ ounces each or 23 ounces to the dozen for pullets.

Abnormally large or small eggs (over 30 or under 23 ounces to the dozen) should not be used. As eggs increase in size, hatchability decreases. Small eggs hatch better, but egg size is inherited and is also correlated with body size. Continuous selection of small eggs for incubating may result in flocks laying too many small eggs eventually. For practical purposes, the range given appears desirable.

This selection of eggs should have been preceded by selecting breeders. The average size, shape, and color of eggs laid by any breeder, because of inheritance, is a fair measure of the eggs her daughters will lay.

2. Caring for hatching eggs

If the best results are to be obtained, several points should be observed in the handling of eggs for incubation from the time they are laid until they are set.

Gathering the eggs. Collect hatching eggs at least three times daily to protect them from extreme heat or cold.

Producing clean hatching eggs. Clean eggs are best for hatching. If the eggs are very dirty, bacteria are likely to have gained access to the inside of the eggs, with harmful results. They should be washed in clean water at 120 to 130 degrees F., containing a sanitizer (see page 167).

Holding the eggs. Research and practical experience indicate the following practices for holding eggs before incubation.

(1) Avoid holding hatching eggs for long periods below 40 degrees F.

(2) Temperatures above 60 degrees F. for long periods are not desirable.

(3) Under most conditions, 50 to 60 degrees F. is a fairly safe range.

(4) Ten days appear to be the time limit for holding, with 2 weeks the apparent maximum. Seven days or less is preferable. When the egg is laid the embryo has reached what one might con-

sider to be a resting stage. At this point in its development, cell division is slowed down considerably. Thus, hatching eggs can be held for several days without apparent injury to the embryo, providing they are held under proper conditions. Nature apparently provided this quiescent period of embryonic development to enable

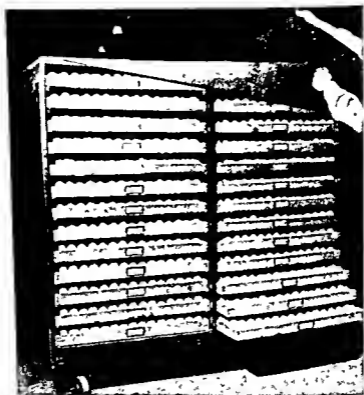


FIG. 179. Covering racks of eggs while holding for the incubator increases the percentage hatched. Courtesy Babcock Poultry Farm, Ithaca, N. Y.

a hen to lay a full clutch of eggs, incubate them, and have them hatch at about the same time.

(5) High rather than low relative humidity is preferred; 75 to 85 per cent appears desirable.

(6) Eggs held longer than 1 week should be turned. Eggs may be packed large end up in precooled, moist egg cases arranged to tip from side to side.

(7) Preheating eggs during the holding period is of doubtful advantage.

(8) Hatchability appears to depend more on the condition of the embryo than upon the interior market quality of the egg.

(9) Prolific layers and birds coming into production produce more hatchable eggs than birds producing at a low rate. A period of 25 to 27 hours between eggs from individual hens results in better hatchability. Embryos withstand bolding better after the gastrulation stage is reached, and before the primitive streak forms. The former is usually reached before the egg is laid, the latter during the first few hours of incubation.

(10) Chick embryos should not be held long under conditions permitting inefficient metabolism. Either start incubation at once after the egg is laid or reduce metabolism to practically a dormant stage, but do not entirely eliminate it. A temperature of 50 to 60 degrees F. appears to accomplish this. Between 60 degrees F. and incubation temperatures, the embryo may use some of the essential factors while others requiring higher temperatures may be metabolized inefficiently, with resultant permanent injury to the embryo.

(11) It is likely that eggs placed in incubators directly from the cool holding room reach a stage of efficient metabolism and growth more quickly and with more favorable results than if permitted to warm through gradually.

(12) A good egg room is a cellar or a well-insulated room, protected from the warm, dry outside air, ventilated, supplied with a method of controlling moisture and temperature, located conveniently, and containing equipment necessary to do the work efficiently.

3. Testing the thermometer

Test the thermometers each season to make certain that they register accurately. Compare with a physician's clinical thermometer in water at about 103 degrees F. If there is any difference, replace with a new incubator thermometer.

4. Preparing the small incubator

After brushing out the remains of the previous hatch, if any, use a sprayer or a scrubbing brush and saturate the interior of the machine with a 2 or 3 per cent solution (preferably in hot water) of a cresol disinfectant (3 ounces of the compound to 1 gallon of water). Clean the heater with a brush or a piece of cloth on a stick. If the isinglass in the heater is dirty, clean with a cloth dampened with vinegar. See that the lamp is clean and the burner and gauze free of foreign material. Level the machine. Renew the

wick after each hatch to avoid danger of its being too short to reach the oil at any time during the hatch.

5. Preparing the mammoth incubator

Follow carefully the directions that come with the machine.

6. Starting the hatch

Eggs may lie on the tray on their side or end, large end up, the position depending on the type of incubator. Eggs may be placed on the incubator trays as they are brought to the egg room or just before they go into the incubator.

Placing cold eggs in the machine lowers the temperature. From 10 to 12 hours is usually required to warm the eggs through and restore the desired temperature in the egg chamber in *still-air* machines. In *forced-draft* incubators, readjustments in the temperature take place more quickly. The temperature may drop 3 to 4 degrees, but will regain the normal point again in 3 to 4 hours.

Higher temperatures result in earlier hatches and lower temperatures in later hatches. If the *still-air* incubator is set at night, the next day is called the first day of incubation. The hatch should be complete the morning of the twenty-second day.

In *forced-draft* incubators, which both incubate and hatch eggs in the same chamber, eggs set at 7 A.M. on the first day should complete the hatch the morning of the twenty-second day.

7. Maintaining the proper temperature

Small incubators. The egg chamber is warmest near the top and coolest near the bottom. A hanging thermometer or one with the bulb above the eggs should register higher than a contact thermometer or one with the bulb on a level with the eggs.

Hanging or standing thermometers should show temperatures about as follows for still-air machines:

	Degrees F.
First week	102.5 to 103
Second and third weeks	102
18th day to end of hatch	100 to 101

Cabinet mammoth forced-draft incubators. When hatching is done in the same machine where eggs are being incubated, the temperature cannot be lowered at hatching time because of the harmful effects on the eggs. Such machines are kept constantly at

about 99.5 degrees F. unless specified otherwise by the manufacturer.

When eggs are transferred to the *separate hatcher* the temperature to the *eighteenth* day is 99.25 to 99.5 degrees F., dropping the *eighteenth* day to 99 degrees F.

8. Maintaining the proper humidity

The relative humidity for best results should be 55 per cent to the *eighteenth* day, and should be increased 5 to 10 per cent from the *eighteenth* day until the end of the hatch.

In *still-air* machines the degree of humidity is generally determined by a reliable hair hygrometer, while in *forced-draft* machines a wet-bulb thermometer is used. In the latter case the reading should be 84 to 86 degrees F., and 88 degrees F. from the *eighteenth* day to hatching time.

The wet bulb is contrived by covering the bulb with a muslin or silk wick, one end of which is inserted into a container of water. If there is an absence of moisture in the egg chamber, the evaporation of moisture from the wick around the bulb of the thermometer increases. Since evaporation is a cooling process, a lower reading results. The higher the humidity in the egg chamber, the slower will be the evaporation and therefore the higher the reading.

Relation between humidity and temperature. The higher the temperature, the greater the amount of water in the air at full saturation. The lower the temperature, the smaller the amount of water at full saturation. Therefore, air at 50 per cent relative humidity and high temperature would contain a proportionately larger amount of water than would air at 50 per cent relative humidity and low temperature.

9. Turning the eggs

Turn the eggs three to four times daily, from the first to the *eighteenth* day of incubation, inclusive. Turning is very beneficial. The hen turns her eggs several times during the day and night and thus presents new albumen between yolk and shell. The yolk rises, being lighter than albumen, but the embryo on the upper surface of the yolk must not reach the shell membrane or it will stick to it and die.

Most modern machines are equipped with quick turning devices which work without removing the eggs. It is not necessary to turn the eggs completely over. When turning by hand with

small machines, if the trays are full, remove a few eggs and with the palms of the hands shuffle the eggs back and forth until all have been moved. If the compartments hold more than one tray, turn the trays end for end one time and from side to side the next. This practice helps expose all eggs to any different temperatures that may exist in the egg chamber.

10. Ventilating the machine

Follow the manufacturer's directions carefully. Oxygen is an important element. The embryo uses about $\frac{1}{4}$ cubic foot of oxygen (O_2) during incubation and produces about $\frac{1}{4}$ cubic foot of carbon dioxide (CO_2). The amount of each is small at first, increasing gradually until toward the end of the period the exchange of gases is considerable. The chick is very sensitive to CO_2 .

During the entire period of incubation it is well not to exceed 0.5 per cent of CO_2 .

Still-air machines need more ventilation near the end of the hatch.

Mammoth machines of the forced-draft type have the air well equalized and no excess of CO_2 .

11. Cooling the eggs

Experiments indicate that special cooling is unnecessary, except if the eggs should become overheated.

12. Testing the eggs

Dead embryos give off harmful gases. In *forced-draft machines* these gases are easily driven away, hence it is not necessary to test and remove them. However, some operators do so on the eighteenth day while changing the eggs to the separate hatcher, or earlier to conserve space. It is customary in *still-air machines* to test twice. White eggs are first tested on the fifth or sixth day, and brown eggs on the seventh or eighth day. Both are again tested on the fourteenth day.

The room in which the eggs are tested should be darkened. Hold the eggs before the light with the large end up, about 12 inches in front of and below the eye (see page 171). Give the egg a gentle turn and the contents will move. If the egg is infertile, the yolk will appear as a dark shadow. The air cell will be considerably larger than in a fresh egg.

The *fertile egg*, at the first test, will have a darkened spot on the yolk, with several red blood vessels radiating from it, resembling a spider. The larger and more distinct the embryo appears, the stronger is the germ.

If the germ appears without the radiating blood vessels and with a whole or partial ring of blood around it, the germ is dead and the egg should be removed.

At the second test, on or about the fourteenth day, remove any eggs in which the germs have died since the first test. In an egg that contains a live germ, large blood vessels are usually seen near the air cell, and frequently the chick is seen to move. Eggs having a dark center with a clear area near the edges are probably dead embryos. The beginner should break open several eggs that appear dead at this test, in order to check up on his judgment.

13. Taking off the hatch

Still-air machines. When dry, the chicks may drop into a nursery below the tray, or may be hardened by lowering the temperature



FIG. 180. *Left:* Part of a good hatch in a mammoth room-type machine. *Right:* Transferring chicks from the hatching trays to boxes, later to be sorted.

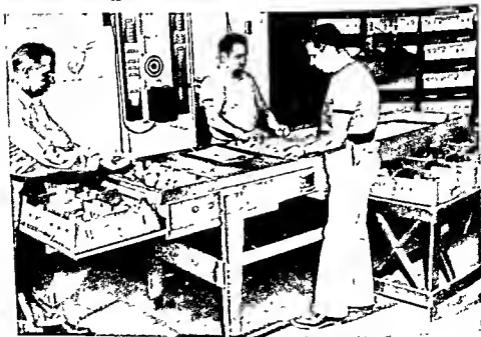
slightly or by opening the incubator door about $\frac{1}{8}$ inch and fastening it.

Forced-draft machines permit the chicks to remain in the hatching trays until all are dry. The chicks may be counted from the



A

FIG. 181. Handling chicks in a modern hatchery. A. Trays of chicks from the incubators are counted into boxes, 26 chicks in each quarter or 104 per box. The boxes are then placed on a rolling table and taken to the chick sexers. B. The sorting table. Sexed chicks are removed from the box at left, placed on the sorting table, which has a movable belt. Men at right remove desirable chicks and place in shipping boxes on tables at right. Chicks not making the grade are carried on the belt and fall off into a box at right. Courtesy Babcock Poultry Farm, Ithaca, N. Y.



B



FIG. 182. Chicks from modern hatcheries and breeding farms are shipped long distances by airplane. Inside the plane, boxes of 100-104 chicks each are carefully fastened to ensure against movement during flight and to permit ventilation between boxes and columns of boxes.



FIG. 183. A shipment of 30,000 American chicks being unloaded at Cairo, Egypt, 31 hours after leaving the United States.

hatching trays into boxes, taken to the sexers, if needed, then replaced in boxes and held in a room at 65 or 70 degrees F., or moved by truck or car.

Chicks smother easily and quickly if air is shut off or they are too warm. Separate the boxes at least 1 inch when placing one above the other, and allow plenty of air on all sides of each box. (Boxes are of corrugated pasteboard and hold 100 chicks divided into groups of 25 plus the extras—usually 2 to 6 for each 100.)

14. Cleaning and disinfecting

The practice of fumigating either just before, during the time chicks are hatching, or afterward has become general. Manufacturers of incubators have prepared directions for fumigation of their particular machines at these periods.

Plan 1—forced-draft. Determine the cubic feet of incubator space. For each 100 cubic feet use 20 cubic centimeters ($\frac{2}{3}$ ounce) of formalin. Cut a piece of cheesecloth, approximately 1 yard for each fan, soak in the formalin, and hang under the fans for about 3 hours. The cloth may be partially twisted and suspended by the ends to hooks so that it hangs loosely. Fumigation is started when there are a few chicks on the trays, and repeated every 12 hours until the hatch is finished. The wet-bulb reading should be about 90 degrees F.

After the chicks are removed, the floor is cleaned with a vacuum cleaner; the trays are brushed clean with a wire brush and returned to the incubator.

The shells and unhatched eggs should be properly disposed of.

Plan 2. When the eggs are transferred to the separate hatcher, measure out the potassium permanganate crystals into a jar or crock. Add the formalin. Place in the machine and close the door. Leave at least 30 minutes.

A simple way to determine the required amounts of chemicals is to use the following chart:

Cu. Ft. of Air Space	Amount of Formalin	Amount of Potassium Permanganate
10	1 teaspoonful	$\frac{1}{2}$ teaspoonful
20	2 teaspoonfuls	1 teaspoonful
50	5 teaspoonfuls	$1\frac{1}{2}$ teaspoonfuls
100	$\frac{1}{4}$ cup	$\frac{1}{4}$ cup
200	$\frac{1}{2}$ cup	$\frac{1}{4}$ cup
400	1 cup	$\frac{1}{2}$ cup

The chemicals are combined in a wide-mouthed earthen or enameled-ware jar. The jar should be large enough to hold at least ten times the amount of chemicals placed in it, so that the chemicals will not boil out over the jar.*

For fumigating *still-air* compartments after the hatch is completed, clean thoroughly, determine the amounts of chemicals needed (use the same chart), place in the machine, and leave for 30 minutes.

The air in the compartment must be warm and moist before the fumigant is placed. The dry-bulb reading should be between 99 degrees and 100 degrees F., and the hair hygrometer reading should be around 68 per cent relative humidity. Moisture and temperature play an important part in determining the efficiency of the gas.†

Remove the hygrometer while fumigating.

After the hatch, clean out the interior and disinfect the compartment and the trays.

15. Hatching with hens

Making the nest. The general requirements of a nest are that it be roomy, cool, well ventilated, protected from enemies, sanitary, secluded, and safe for the newly hatched chicks. The nest should be 12 to 16 inches square and a few inches deep. A good nest can be made by removing the bottom from a small dry-goods box.

Coops are used out of doors for one or more hens. In any case, the hen may be given freedom to the extent of a small yard, which should be shady. The nesting material used when setting hens is generally oat straw, wheat straw, fine hay, cut straw, or clean chaff, placed on a sod or several inches of moist earth, packed well into the corners and hollowed in the center to hold the eggs.

Setting the hen. When a good sitter is found, she should be gently transferred to the hatching room or hatching coops.

The transfer should be made at night. The hen should be thoroughly dusted with a good lice powder, and this dusting should be repeated 3 or 4 days before the eggs hatch.

It is well to set the hen on several eggs that are not to be used for hatching, until she becomes accustomed to her surroundings. If she does not leave the nest except for food or for water during the following day, it is generally safe to place the eggs for hatching

* E. L. Brunett, "Poultry Diseases," *Cornell Ext. Bull.* 377, Cornell Univ., Ithaca, N. Y., 1939.

† Brunett, *op. cit.*

under her the following night. The number of eggs to be set will depend upon the size of the hen and the weather conditions, and will usually range from 12 to 15 eggs in early spring, and 2 or 3 more during warmer weather.

Feeding the hen. During the entire hatching period, feed the hen once daily with grain only. In addition, plenty of fresh water and a small amount of grit should be supplied.

Important details. If eggs are broken in the nest, they should be removed at once and fresh nesting material supplied. If the remaining eggs are smeared, they should be washed with warm water.

At the end of the first and second weeks, the eggs should be tested and those that are infertile or contain dead germs should be removed. If several hens are set at the same time, the eggs from two hens may often be placed under one after the undesirable eggs have been removed. The extra hens may then be set again or placed in a special coop for breaking up broody hens. Sitting hens should be looked after daily, especially if they show a tendency to stay off the nest too long.

Community Survey

1. Spend a period or more at a local hatchery and describe the various operations performed in caring for the incubator.
2. What points are emphasized in the selection of hatching eggs? Why?
3. What attention is given to moisture within the machine?
4. Are hatching eggs cooled? Turned? Tested? Why or why not?
5. What temperature is used each week in still-air machines? In forced-draft machines?
6. How long are chicks left in the machine after hatching?
7. Does the hatchery pedigree-hatch its chicks?
8. List the various steps used in pedigree-hatching.
9. Which give the best results in pedigree-hatching, bags or baskets?
10. Visit a hatchery and record (a) capacity of machines; (b) how many times they are filled in a season or year; (c) how many chicks are sold; (d) the percentage hatched of total eggs, of fertile eggs; (e) the percentage of all chicks sexed; (f) the percentage of all eggs set that are produced on outside farms.

Reference

Hartman R. C. and G. S. Vickers. *Hatchery Management*, Orange Juilli Publishing Co., New York, 1932.

The Art of Knowing Chickens

A practical poultryman will find many phases of poultry work interesting. A boy or girl with a 4-H or F.F.A. project or a poultry enterprise in city, village, or country may find stimulation leading to further study of nutrition, breeding, management, incubation, teaching, and the like, or the desire to own and operate a large commercial poultry enterprise. The farmer should find that an interest in poultry matters beyond his daily chores is of value to his work.

Nearly everyone enjoys poultry shows and fairs and finds pleasure in the many breeds and varieties shown there, some developed for their economic value and others bred by fanciers for show and exhibition purposes. Many may wish to enter birds in a show, to compete on a production or fancy exhibition basis, or to understand the class, breed, and variety of a particular bird or group of birds.

The fancier. Whoever works with poultry becomes in some degree a fancier. This is a name given to those who keep poultry largely for pleasure and useful amusement. The fancier takes pride in possessing fine fowl; in understanding and practicing the laws of breeding and thereby developing new breeds, with particular interest in plumage pattern; in competing at shows for fowl most nearly approaching perfection as described in the *American Standard of Perfection*; in engaging mind and body with a fascinating sideline. He belongs to the American Poultry Association (A.P.A.) and has some part in the development and publication of the *American Standard of Perfection*.

The many poultry varieties recognized today—possessing distinctive combinations of feather patterns, differences in body size and shape, and the tendency for many birds to breed reasonably true to these and to class characteristics—are largely the work

of fanciers, and they constitute a never-ending source of amazement to all lovers of poultry. Shows featuring the fancy breeds and varieties are held throughout the world.

Much of the stimulation given to the development of economic interest in poultry, from which has grown the tremendous industry of today, had its start in the fancier's back yard. Qualities in poultry which lent themselves so readily to the external changes desired by the fancier, who was interested primarily in the beauty of plumage and form of body, were later developed by the production breeder to produce more eggs and poultry meat for human food.

Standards. The *American Standard of Perfection*, a book published by the American Poultry Association, is the official guide for judging exhibition poultry. Designed for and used by fanciers in judging shows and exhibitions, it has of late included much that is related to production-bred poultry. First published in February 1874, the book is revised and brought up to date every 5 years.

All recognized breeds and varieties of poultry are listed in the "Standard," together with a description of the size, shape, and color of each, both male and female, with many illustrations. Defects and disqualifications for the breeds and for the varieties are described.

New breeds are not recognized as such until accepted for publication in the "Standard."

Classes, breeds, and varieties. The "Standard" classifies fowls under class, breed, and variety.

Class refers, usually, to the place of origin, as Asiatic, American, Mediterranean.

Breed consists of a group of fowls having distinct size and shape characteristics and a large degree of similarity in habits, as Leg-horns, Brahmas, New Hampshires.

Variety refers to fowls within the breed but differing in type of comb, color of plumage, and presence or absence of crest, beard, or muff.

Strain is a family of any variety of fowls bred in line of descent by one person or by one person and his successor, during a number of years, and that has acquired individual characteristics which distinguish it more or less from other strains or specimens of the same variety. There may be greater differences between strains

of fowls than between varieties or, in many cases between the breeds within a class.

The prospective poultry keeper has a larger number of breeds and varieties to select from than has any other livestock farmer. These differ widely in size, type, color, vitality, and productivity. It is not only desirable but quite often fun to be able to tell the class, breed, and especially the variety of the birds one sees.

When one considers the extreme differences in size, shape, and color that are found among the numerous breeds and varieties, and realizes that all presumably originated from one or two wild species which may even now be found in their native haunts, the results seem little less than marvelous. Though the same color patterns of plumage may be found in several breeds, all varieties differ one from another in some respect.

Space prohibits any attempt to discuss the historical development of breeds here.

Operations:

1. Studying the parts of a fowl.
2. Studying the shape and location of feathers.
3. Studying plumage color patterns.
4. Studying comb types.
5. Studying heads.
6. Studying shanks and toes.
7. Studying body shape.
8. Identifying breeds and varieties.

General information:

1. Fitting and exhibiting.
2. The egg show.

Operations

1. Studying the parts of a fowl

Definitions and key to the diagrams of the body parts and feather sections. Refer to Figs. 184, 185, 186, and 187.

1. Head. 2. Beak. 3. Nostril. 4. Comb. 5. Face. 6. Eye. 7. Wattle.
8. Ear. 9. Earlobe.
10. Hackle. The plumage on the neck of a male.
11. Front of hackle. (See Fig. 184.)
12. Neck. The part of the fowl which unites the body with the head and allows the head to be turned freely in various directions.
13. Front of neck. See illustration of female.

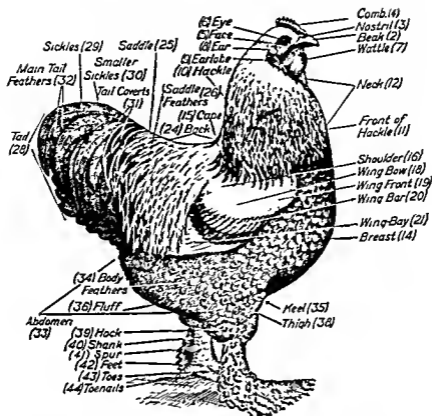


FIG. 184. Parts of a male. Drawn from the *American Standard of Perfection*.

14. Breast. The part of the fowl extending from the lower part of the neck to the keel.
15. Cape. The feather section at the junction of the neck and back just beneath the hackle of the male or neck feathers of the female.
16. Shoulder. The upper section of the wing.
17. Wing. Used in flight. (See Fig. 185.)
18. Wing bow.
19. Wing front.
20. Wing coverts (wing bar).
21. Secondaries (wing bay).
22. Primaries (flight feathers). Hidden by secondaries or wing bay.
23. Primary coverts. Hidden by secondaries or wing bay.
24. Back. The part of the body between the neck and the saddle or cushion.
25. Saddle. The feather section of the male overlapping the base of the tail.
26. Saddle feathers. Extending downward to form the lower saddle.
27. Cushion. The feather section of the female overlapping the base of the tail.
28. Tail. The rump and the feathers which are found on it.
29. Sickles.
30. Smaller sickles.

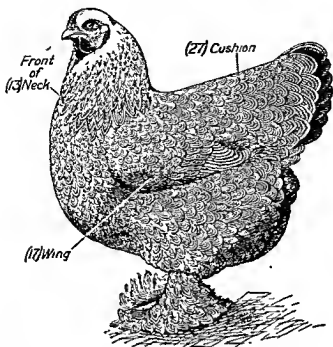


FIG. 185. Parts of a female. Drawn from the *American Standard of Perfection*.

- 31. Tail covers.
- 32. Main tail feathers.
- 33. Abdomen. The part of the body between the rump and the keel.
- 34. Body feathers.
- 35. Keel. The sternum. (Fig. 206.)
- 36. Fluff.
- 37. Leg. Used in locomotion, including the feet, shank, hock, thigh, and second joint.
- 38. Thigh. That part of the leg above the hock. The "first joint" or drumstick formed by the fibula and tibia, and "second joint" formed by the femur. (Fig. 206.)
- 39. Hock. The joint between the thigh and the shank.
- 40. Shank. The part of the leg between the foot and the hock. (The metatarsus, Fig. 206.)
- 41. Spur. The horny growth on the shank.
- 42. Feet. The lower parts of the legs, including the toes.
- 43. Toes. The appendages of the feet.
- 44. Toenails. The nails on the end of each toe.

2. Studying the shape and location of feathers

Figures 186 and 187 show drawings of feathers from different sections of the body. In studying feathers from birds of the same variety, notice that there is always a similarity and that feathers of the same size and shape will always be found on the same section of birds of the same sex and same variety. The feathers

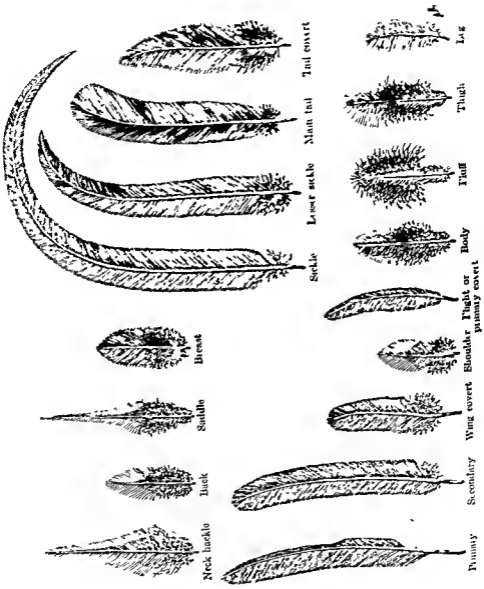


FIG. 188. Feathers of the male.

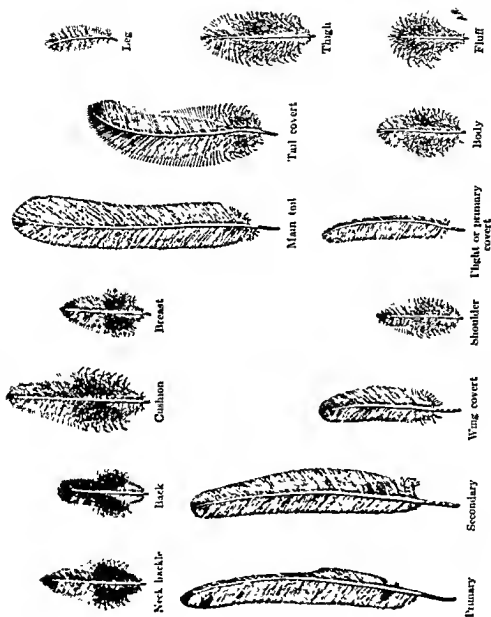


Fig. 187. Feathers of the female.

Table 28. Feather Identification

Section	Name of Feathers	Definition
Neck	Hackle	The long, narrow, pointed feathers found on the neck of the male, and more blunt on the female.
	Cape	Short feathers under the hackle.
Back	Back feathers	The short, broad feathers of the back.
Saddle	Saddle	The narrow, pointed feathers overlapping the base of the tail of the male and extending downward.
Cushion	Cushion feathers	The round-tipped feathers overlapping the base of the tail on the female.
Breast	Breast feathers	The short, broad feathers covering the breast.
	Sickle feathers	The longer flowing feathers of the tail of the male.
	Smaller sickles	The shorter flowing feathers of the tail of the male.
Tail	Main tail feathers	The broad, flat, upright feathers of the tail.
	Tail coverts	The smaller, flowing, pointed feathers in the male and the more blunt feathers in the female, extending partly over the main tail feathers.
	Primaries	The 10 long, stiff feathers on the outer (metacarpus) section of the wing. (Fig. 205.)
	Secondaries	The large feathers which grow on the wing section formed by the ulna and radius. When the wing is folded they are seen at the lower end. The wing bay.
Wing	Wing coverts	The feathers overlapping the base of the secondaries. In parti-colored varieties they frequently form a distinct bar across the wing. The wing bar.
	Wing bow	The short feathers overlapping the wing coverts.
	Flight, or primary coverts	The small feathers at the very point of the wing.
Body	Body feathers	The medium-sized feathers covering the body where not otherwise protected.
Fluff	Fluff feathers	The soft feathers covering the abdomen back of the legs and below the tail.
Thigh	Thigh feathers	The short, fluffy feathers covering the thighs.
Shank	Leg feathers	The stiff feathers found on the shanks of feather-legged varieties.

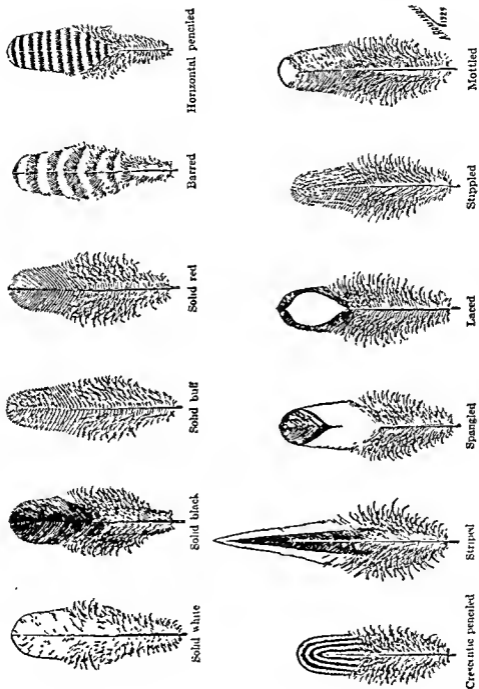


FIG. 188. Feather color patterns.

from each section differ in shape, size, and structure from feathers on other sections of the same fowl. This difference is always found in normally developed fowls.

The illustrations show the relative size, structure, and name of each type of feather.

Compare the feathers from the corresponding section of the male and female. Note that there is little or no difference, except perhaps in size, between the following: leg, thigh, fluff, flight covert, wing covert, secondary, primary, main tail, and breast.

The remaining feathers (with the exception of the sickle and smaller sickle, which do not appear on the female) are more pointed in the male. (This difference in structure and shape of the saddle and hackle of the cockerel and the cushion of the pullet is often used in determining sex when separating cockerels and pullets during the brooding and rearing season.)

3. Studying plumage color patterns

Many variations of these colors are found; for example, rich golden buff, pale or light buff, or medium buff (Fig. 188).

Table 29. Plumage Color Patterns

Pattern	Definition	Example Varieties
Barred	A feather having bars across the web at right angles to the shaft.	Barred Plymouth Rock, Dominique
Horizontal Penciling	A feather having narrow straight stripes across the vane at right angles to the shaft.	Silver or Golden Penciled Hamburgs, Golden or Silver Campines
Crescentic Penciling	A feather having narrow stripes on the vane which follow the outline of the feather, forming a crescent.	Partridge Cochins, Partridge Wyandotte
Striped	A feather having a stripe through the center on a web of another color.	Hackle of Brahmas or Brown Leghorns
Spangled	A feather having a dark-colored, roundish marking on the vane near the tip.	Silver or Golden Hamburgs
Laced	A feather having an edge or border differing from the color of the central part of the feather.	Silver or Golden Wyandotte

Table 29. Plumage Color Patterns (continued)

Pattern	Definition	Example Varieties
Stippled	A feather having fine dots sprinkled or stippled over a vane of a different color.	Brown Leghorn female
Mottled	A dark-colored feather tipped with white.	Houdans or Anconas

Feather Coloration

Solid White	A feather without other color than pure white.	White Wyandotte White Leghorn
Solid Black	A feather without other color than black.	Black Minorca Black Langshan
Solid Buff	A feather without other color than buff.	Buff Cochins Buff Plymouth Rock
Red	A feather without other color than red.	Rhode Island Red

It is only rarely that perfectly marked plumage will be found in all sections of a fowl. Frequently, birds of a known variety are so poorly marked, both in distribution of the feathers and in the color patterns, that they have little value for selling or exhibiting. Therefore, in identifying birds according to plumage color, practice and experience are great helps.

4. Studying comb types

The well recognized types of combs to be found on our domestic fowls are described in Table 30. (See Figs. 189 to 192.)

Table 30. Comb Types

Comb	Definition	Example Varieties
Single	A single serrated (notched) fleshy growth on top of the head. It may be large, medium, or small; thick or thin; deeply or lightly serrated; erect or lopped depending on the variety or sex.	Rocks, Leghorns
Rose	A thick, solid comb, covered at the top with fine points and terminating in a spike at the rear.	Hamburgs, Wyandottes, Rose Comb Rhode Island Reds
Pea	A comb resembling three low, thick, slightly serrated, single combs, the center comb slightly higher than the other two.	Brahma, Sumatra

Table 30. Comb Types (continued)

Comb	Definition	Example Varieties
V	A comb consisting of two small, divided, hornlike or leaflike projections, joined at their base.	Houdan, Polish, Crève-cœur
Strawberry	A fleshy growth so named because of its similarity in shape and color to the outer part of half a strawberry with the large end foremost.	Malay
Cushion	A solid, low comb, set well forward, front and rear square, side straight, and having a smooth surface.	Chanticleer
Buttercup	A deep, cup-shaped, fine-textured comb formed by a circle of serrations, resting on a single base.	Buttercup

5. Studying heads

The main difference in the head points which differentiate between breeds and varieties of fowls, in addition to the comb, are as set forth in Table 31. (See Fig. 189.)

In Holland, the single comb has 6 points and is the main distinguishing character to differentiate from White and Barred Rocks.

Table 31. Other Head Characters

Characters	Definition	Example Varieties
Beard	A group of feathers hanging from the throat.	Sultan, certain varieties of Polish
Muff	A group of feathers on the sides of the face below the eyes, extending from the beard to the earlobes. Found only on bearded varieties.	Sultan, certain varieties of Polish
Crest	A group of feathers on top of the head.	Sultan, certain varieties of Polish
White face	Enlarged earlobes meeting in front of and extending well backward and downward on each side of the neck, and covering the face.	Black Spanish

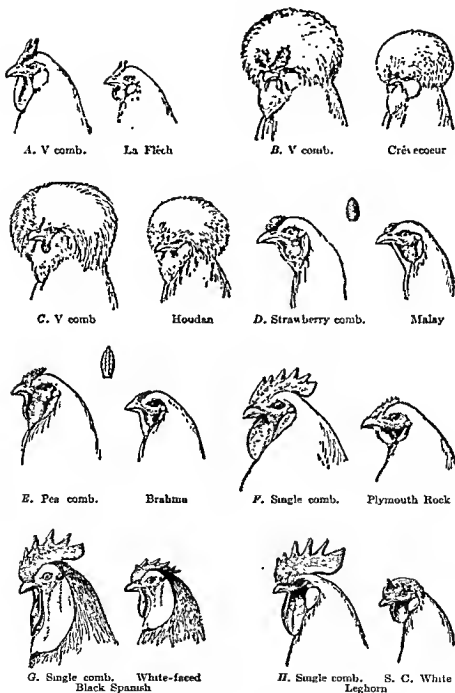


FIG. 189. Types of combs and heads.

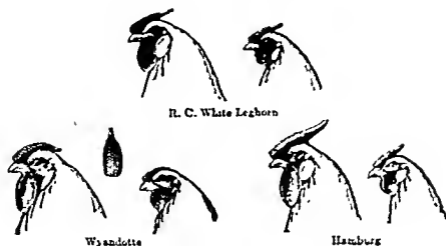


FIG. 190. Rose comb types. Note position of the spike.



FIG. 191. Cushion comb. Drawn from the *American Standard of Perfection*.



FIG 192 Buttercup comb



FIG 193. A five-toed foot.

Table 32. Shank and Toe Feathers

Characters	Definition	Example Varieties
Feathered shanks	Shanks feathered down the outside from thigh to toes. Feathering differs with the variety; for example, on Cochins and Brahmas the middle and outer toes are feathered, while on the Langshan the middle toe should be free of feathers.	Brahmas, Cochins, Langshans
Vulture hocks	Stiff quill feathers growing on the thighs, extending backward, straight beyond the knee joint or hock.	Sultan, Mille Fleur, Booted Bantams

6. Studying shanks and toes

Most varieties of fowls have four toes on each foot. In a few cases, such as the Houdan, Faverolle, Sultan, and Dorking, there

STANDARD DIFFERENCES IN BODY SHAPE



MEDITERRANEAN CLASS

Leghorns  Anconas  Minorcas .

Fig. 194. Three important standard varieties of the same class superimposed to show general uniformity of shape. Note difference in back lines.



AMERICAN CLASS

Plymouth Rocks



R. J. Reds



Wyandottes



ASIATIC CLASS

Brahmas



Cochins



Langshans



FIG. 195. Three important varieties of the American and Asiatic classes superimposed. Note general similarity in type and differences in tail, fluff, and breast by classes.

are five toes on each foot (Fig. 193). The fifth toe is located below the spur and above the rear or first toe (Fig. 206).

7. Studying body shape

A study of Figs. 194 and 195 shows differences in body shape between certain breeds of fowls, as outlined in the *American Standard of Perfection*. Occasionally the shape or size of body

will be the only difference between certain varieties of fowls. For example, the Rose Comb Rhode Island White is similar to the White Wyandotte except in shape of body. The Jersey Black Giant and the Black Java are similar as they appear side by side except that the Giant is supposedly larger. (Examination of the undercolor should show a difference, the Black Java being dull black and the Jersey Black Giant slate color shading to white at the skin.)

It is well, therefore, to become familiar with the shape of several outstanding breeds at least in the three classes, American, Mediterranean, and Asiatic.

8. Identifying breeds and varieties

When determining the varieties, observe the characters in the following order. (See key on page 382.)

(1) Earlobe	Red or white
(2) Shanks	Feathered or nonfeathered
(3) Skin	Yellow or white
(4) Toes	4 or 5
(5) Feathering	Loose or close
(6) Comb	Single, rose, pea, V, strawberry, cushion, or buttercup
(7) Size	Large or small
(8) Crest	Present or absent
(9) Beard and muff	Present or absent
(10) Plumage	Color

Example. It is well to try the key with a bird of a known variety. When the method of using it is thoroughly in mind, it may be used with birds the variety of which is unknown to the person using the key.

Suppose, for example, we have a bird and wish to determine the variety. Examining the bird in accordance with the general plan given above and the key on page 382, we find the following:

Example 1.—Bird No. 1

<i>Characters</i>	<i>The Bird</i>
Earlobes	Red
Shanks	Nonfeathered

Since *A* is "Shanks feathered" (page 382), we must turn to *B* on page 383. There we find "Shanks nonfeathered."

Now proceed with the next character, which is skin color.

Skin	Yellow
Feathering	Loose
Comb	Rose
Size	Large
Plumage	White

The variety is White Wyandotte.

It will be seen that when a character is found on the key the next character to consider is the one directly following.

Example 2.—Bird No. 2

<i>Characters</i>	<i>The Bird</i>
Earlobes	White

Since classification I in the key is "Earlobes red" it will be necessary to turn to page 386 under II "Earlobes white."

Shanks	Nonfeathered
Skin	Yellow
Comb	Single
Plumage	White

The variety is White Leghorn.

Key for breed identification *

The following key has been revised to apply to all 1953 Standard Varieties of Fowls (large-size).† The key may be used either for identifying varieties or in noting how the varieties differ in the arrangement of external characters.

I. Earlobes red

A. Shanks feathered

1. Skin yellow

a. Comb pea

(1) Size large

Plumage.

(a) Body white, hackle and tail black
laced with white

Light Brahma

(b) Male—breast black, back silvery white
Female—gray with dark crescentic
penciling

Dark Brahma

(c) Buff

Buff Brahma

* First worked out in 1910 by C. A. Rogers, formerly of Cornell University.

† Bantams are not listed in this key. Those interested in the characteristics of the many varieties are referred to the latest edition of the *American Standard of Perfection*. A key may be made for bantams since the external patterns follow similar arrangements. The 1953 A.S.P. lists 75 varieties.

b. Comb single

(1) Size large

Plumage:

(a) Black

Black Cochin

(b) Buff

Buff Cochin

(c) Male—breast black, back red

Female—brown with black crescentic
penciling

Partridge Cochin

(d) White

White Cochin

2. Skin white

a. Toes—4

(1) Comb single

(a) Size large

Plumage:

(1) Black

Black Langshan

(2) White

White Langshan

b. Toes—5

(1) Comb single

(a) Beard and muff

Plumage:

(1) Male—breast black, back reddish-brown

Female—salmon brown

Salmon Faverolle

(2) Comb V

(a) Crested and bearded

Plumage:

(1) White

Sultan

B. Shanks nonfeathered

1. Skin yellow

a. Feathering loose

(1) Comb rose

(a) Size large

Plumage:

(1) Barred

Dominique

(2) Black

Black Wyandotte

(3) Buff

Buff Wyandotte

(4) Body white, hackle and tail black laced
with white

Columbian Wyandotte

(5) Golden, laced with black

Golden Wyandotte

(6) Male—breast black, back red

Female—brown with black crescentic
penciling

Partridge Wyandotte

(7) Silver laced with black

Silver Wyandotte

(8) Male—breast black, back silvery white

Female—gray with dark crescentic
penciling

Silver Penciled Wyandotte

(9) White

White Wyandotte

(10) White, back long and horizontal

B. C. Rhode Island White

(11) Red

B. C. Rhode Island Red

(2) Comb single

(a) Size large

Plumage:

- | | |
|---|-------------------------------|
| (1) Rich red | S. C. Rhode Island Red |
| (2) Medium chestnut red | New Hampshire |
| (3) Black, undercolor dull black | Black Java |
| (4) Black, size larger than Java, undercolor slate shading to white at skin | Jersey Black Giant |
| (5) White, size larger than the White Plymouth Rock | Jersey White Giant |
| (6) Black with white-tipped feathers | Mottled Java |
| (7) Barred | Barred Plymouth Rock |
| (8) Buff | Buff Plymouth Rock |
| (9) Body white, hackle and tail black, laced with white | Columbian Plymouth Rock |
| (10) Male—breast black, back red | |
| Female—brown with black crescentic penciling | Partridge Plymouth Rock |
| (11) Male—breast black, back silvery white | |
| Female—gray with dark crescentic penciling | Silver Penciled Plymouth Rock |
| (12) White | White Plymouth Rock |
| (13) White, breast full, body low on hocks | Lamona |
| (14) White, hackle and tail white crossed with irregular black barring | Delaware |
| (15) Blue | Blue Plymouth Rock |

(3) Comb single, 6 points

(a) Size large

Plumage:

- | | |
|------------|----------------|
| (1) White | White Holland |
| (2) Barred | Barred Holland |

b. Feathering close

(1) Comb pea

Plumage:

- | | |
|--|-------------------------|
| (a) Black | Black Sumatra |
| (b) Male—breast black, back red | |
| Female—red with black crescentic penciling | Dark Cornish |
| (c) Red with white lacing | White Laced Red Cornish |
| (d) White | White Cornish |
| (e) Buff | Buff Cornish |

(2) Comb single

(a) Size large

Plumage. Tail rather short, compact, closely folded;
hackle short, close to body

- | | |
|--|-------------------------|
| (1) Breast black, laced with white | Birchen Game |
| (2) Black | Black Game |
| (3) Male—breast black, back red, hackle golden | |
| Female—back grayish brown stippled with golden brown | Black Breasted Red Game |

- (4) Breast black, laced with lemon **Brown Red Game**
- (5) Male—breast black, back and wing
bows golden
Female—breast rich salmon, back gray stippled with
darker gray **Golden Duckwing Game**
- (6) Male—breast white, back red
Female—breast salmon, back white **Red Pyle Game**
- (7) Male—breast black, back and wing bows silver
Female—breast light salmon, back light gray stippled
with darker gray **Silver Duckwing Game**
- (8) White **White Game**
- (3) Comb strawberry
- (a) Size large
Plumage:
- (1) Male—breast black, back red
Female—cinnamon brown **Black Breasted Red Malay**
- (4) Comb cushion
Plumage:
- (1) White **White Chanticleer**
- (2) Male—breast black, back red
Female—brown with black crescentic
penciling **Partridge Chanticleer**
2. Skin white
- a. Feathering loose
- (1) Toes—4
- (a) Comb rose
- (1) Size large
Plumage:
- (a) Male—breast black, back red
Female—brown with black spangles **Redcap**
- (b) Comb single
Plumage:
- (1) Black **Black Orpington**
- (2) Blue **Blue Orpington**
- (3) Buff **Buff Orpington**
- (4) White **White Orpington**
- (5) Red **Red Sussex**
- (6) Reddish brown, each feather tipped with a bar of
black and a white spangle **Speckled Sussex**
- (7) White, hackle and tail black edged
with white **Light Sussex**
- (8) Black, legs and toes dark slate **Australorp**
- (c) Comb V
Plumage:
- (1) Black, bearded and crested **Crèvecoeur**
- (2) Toes—5
- (a) Comb rose
Plumage:
- (1) White **White Dorking**

(b) Comb single

Plumage:

- (1) Male—breast black, hackle and saddle straw color
 Female—breast dark salmon edged with black, back
 black with light bay shafting **Colored Dorking**
- (2) Male—breast black, back and hackle silvery white
 Female—back gray, stippled with
 darker gray **Silver Gray Dorking**

b. Feathering close

(1) Comb single

Plumage: Tail well spread; hackle long,
covering shoulders**Old English Game**

(2) Comb pea

Plumage:

- (a) Male—Body and front of neck black; primaries, secondaries, tail black edged with bay; head and hackle chestnut

Female—Same except body and front of neck cinnamon,
 main tail feathers edged with cinnamon

Black Breasted Red Cubalaya

(b) White

White Cubalaya

(c) Black

Black Cnbalaya

II. Earlobes white

A. Shanks nonfeathered

1. Skin yellow

a. Comb rose

Plumage:

- (1) Male—breast black, back red, neck and hackle red, front of
 neck black

Female—back dark brown stippled with black

B. C. Dark Brown Leghorn

- (2) Male—breast black, back red, neck and hackle orange, front
 of neck black slightly mottled with salmon

Female—back light brown, stippled with darker brown

B. C. Light Brown Leghorn

(3) White

B. C. White Leghorn

(4) Black with white-tipped feathers

B. C. Mottled Ancona

b. Comb single

Plumage:

(1) Black

S. C. Black Leghorn

- (2) Male—breast black, back red, neck and hackle red, front of
 neck black

Female—back dark brown stippled with black

S. C. Dark Brown Leghorn

- (3) Male—breast black back red, neck and hackle orange, front
 of neck black slightly mottled with salmon

Female—back light brown, finely stippled with darker brown

S. C. Light Brown Leghorn

(4) Buff

S. C. Buff Leghorn

(5) Male—breast black, back and hackle silvery white

Female—gray stippled with darker gray

S. C. Silver Leghorn

(6) Red

S. C. Red Leghorn

(7) Red with main tail feathers black

S. C. Black-Tailed Red Leghorn

(8) White

S. C. White Leghorn

(9) Body white, hackle and tail black laced with white

S. C. Columbian Leghorn

(10) Black with white-tipped feathers

S. C. Mottled Ancona

c. Comb buttercup

Plumage:

(1) Male—red, sickles black

Female—back golden buff with black spangles

Buttercup

2. Skin white

a. Toes—4

(1) Comb rose

(a) Size large

Plumage:

(1) Golden with black spangles

Golden Spangled Hamburg

(2) Silver with black spangles

Silver Spangled Hamburg

(3) Male—reddish bay, secondaries with black parallel penciling

Female—bay with black parallel penciling

Golden Penciled Hamburg

(4) Male—body white, secondaries with dark parallel penciling

Female—white with black parallel penciling

Silver Penciled Hamburg

(5) White

Shape:

(a) Back short and curved, comb small

White Hamburg

(b) Back long and straight, comb large

R. C. White Minorca

(6) Black

Shape:

(a) Back short and curved, comb small

Black Hamburg

(b) Back long and straight, comb large

R. C. Black Minorca

(2) Comb single

Plumage:

(a) Blue

Blue Andalusian

(b) Golden with black parallel penciling

Golden Campine

(c) Silver with black parallel penciling

Silver Campine

(d) White

S. C. White Minorca

Practical Poultry Management

- (e) Black
 - (1) Red face S. C. Black Minorca
 - (2) White face White Faced Black Spanish
- (f) Buff S. C. Buff Minorca
- (g) Body surface white; head, neck, and tail deep rich black Lakenvelders
- (3) Comb V
 - (a) Noncrested or bearded
 - Plumage: La Flèche
 - (1) Black
 - (b) Crested but not bearded
 - (1) Size large
 - Plumage:
 - (a) Golden, laced with black Nonbearded Golden Polish
 - (b) Silver, laced with black Nonbearded Silver Polish
 - (c) Body black, crest white White Crested Black Polish
 - (d) White Nonbearded White Polish
 - (e) Buff laced with lighter buff Nonbearded Buff Laced Polish
 - (c) Crested and bearded
 - (1) Size large
 - Plumage:
 - (a) Buff laced with lighter buff Bearded Buff Laced Polish
 - (b) Golden laced with black Bearded Golden Polish
 - (c) Silver laced with black Bearded Silver Polish
 - (d) White Bearded White Polish
- b. Toes—5
 - (1) Comb V
 - (a) Crested and bearded
 - Plumage:
 - (1) Black and white-tipped feathers Mottled Houdan
 - (2) White White Houdan

Miscellaneous:

Feathers curled; comb single, plumage black, white, red, or bay Frizzle

General Information

1. Fitting and exhibiting

Selecting birds for exhibition. Select birds which seem most representative of the variety in the production or standard breed characteristics, depending upon the type of show.

For example, a production White Leghorn pullet will have yellow shanks, with the beak in various stages of yellow. A produc-

tion hen has bleached shanks, feet, beak, earlobe and vent, and may or may not be molting. Other characters are found in chapters on culling and selection.

When birds are to be shown from the standpoint of production qualities, the chapters on culling and selection should be carefully reviewed and birds selected which possess the characteristics needed.

A Leghorn in the exhibition or fancy group would conform more to the standard which calls for yellow skin throughout, and therefore should not be laying.

Preparing birds for show. Birds sent to a show should be reasonably clean. Many will need only the shanks, feet, and head washed. Others may need the plumage cleaned.

MATERIAL FOR WASHING BIRDS FOR EXHIBITION

Three ordinary washtubs

Ivory soap

Sponge

Scrub brush

A room heated to approximately 90 degrees F.

Clean, soft water

Arrange three tubs containing clean, soft water on a bench at convenient height. The temperature of the water in tub No. 1 should be about 90 degrees, in No. 2 lukewarm, and in No. 3 ordinary air temperature. Dissolve one cake of Ivory soap in tub No. 1, and form suds. Submerge the bird completely, except the head. Sponge the plumage thoroughly and make certain that all the dirt has been removed clear to the skin by squeezing gently, but not rubbing, with the hands. With the scrub brush, remove all dirt and old scales from the shanks and feet. When the bird is thoroughly cleaned, transfer it to tub No. 2, submerging and withdrawing, permitting the water to remove all the suds from the plumage. Then dip the bird in tub No. 3 for an additional rinsing and to accustom it to the cooler temperature of the room.

Provide clean litter in clean coops in which to place the birds while drying. Do not place them in a draft.

Place the birds in a partly darkened room until nearly dry; then give more light, so they will dress their plumage.

Provide a temperature not lower than 70 degrees or higher than 90 degrees. A lower temperature would be uncomfortable for the birds because of rapid evaporation of moisture, and a higher

temperature would be likely to dry the plumage too quickly and leave it in a crumpled condition. The birds can be depended upon to put their plumage in proper order during the drying process.

Training birds for exhibition. Provide a room containing coops similar to those in which the birds are to be exhibited. There the birds may become coop-wise and may be further observed before being shipped to the show.

The most intelligent birds are likely to be the best ones for exhibition. Such birds will usually respond quickly to training. They should be taught to be friendly and not easily frightened, in order to show to best advantage their type, carriage, and action.

With the aid of a short rod, a bird can be trained to move about the coop without fright and to feel perfectly at home when viewed by the judge and spectators.

At the show. Before, during, and after the judging takes place, compare your entry with others and attempt to rate the entries, making note of where your birds stand. If possible, watch and listen for comments by the judge, and after he has placed the class, ask him about your entry to learn the points where it excelled and those where it was weak.

After the show. If the bird is not too valuable, it may be sold. The danger of introducing disease to the home flock is always present. At any rate, keep such birds in isolation and away from the main flock for several days for observation.

2. The egg show

The object should be educational, to encourage the production of better quality market eggs. The score card (Table 33) lists the many factors that must be considered when selecting eggs to be entered in an egg show.

Community Survey

- 1 How many varieties of poultry are kept in your locality?
- 2 Which variety is the most popular? Why?
- 3 Arrange the other varieties in the order of their apparent importance.
- 4 What reasons can you give for this arrangement?
- 5 How many varieties of chickens are exhibited at the local or county fair?
- 6 How does this fair exhibit express the popularity of poultry in the county?

Table 33. Score Card for Egg Shows

		Cuts	Total Cuts
Exterior quality:			
1. Size (dozen)			
Cut 6, if av. wt is within 1 oz. above or below class wt., cut 12, if more than 1 oz. See disqualification on total wt. ¹			
2. Uniformity of weight (per egg):			
$\frac{1}{2}$ for each egg varying from the average appearance of size			
3. Uniformity of shape:			
$\frac{1}{4}$ for each egg differing from average			
4. Uniformity of color:			
$\frac{1}{4}$ for cream or tint in white eggs; or varying from average color in brown eggs			
5. Shell texture:			
$\frac{1}{4}$ for rough shell, porous shell or blind check			
1 for each leaker, smashed, or cracked egg			
6. Condition (cleanliness, etc.):			
$\frac{1}{4}$ - $\frac{1}{2}$ for dirty or stained eggs			
Interior quality:			
AA	No cuts		
A	Cut $\frac{3}{4}$ point for each A		
B	Cut $1\frac{1}{2}$ points for each B		
C	Cut $2\frac{1}{4}$ points for each C (incl. small blood and meat spots)		
TOTAL CUTS		X	
SCORE		X	

¹ Disqualifications:

1. Total wt. of large eggs less than 22 oz. per doz
2. Total wt. of medium eggs less than 20 oz. per doz
3. Inedible eggs, including large blood and meat spots or germ development.
4. Signs of incubation.

7. If a crossbreed is popular, what breeds were crossed to obtain it? What is its commercial use?

8. How many classes, breeds, and varieties are listed in the "Standard"?

9. Divide these into large chickens, bantams, ducks, geese, and turkeys.

10. Which of these do you consider to be of the most economic importance?

Shall I Be a Poultryman?

The choice of an occupation is one of the most important decisions that we are ever called upon to make. In considering the poultry business, one should carefully weigh the main factors upon which success in this field depends.

General information:

1. The personal inventory.
2. The labor problem.
3. The necessary cash and credit.
4. Limitations of the business.
5. Special advantages of the business.
6. Methods of getting started in the business.

1. The personal inventory

In choosing an occupation one should first consider the personal characteristics necessary for success. Some persons might succeed very well in a city occupation and yet fail in a farming occupation like poultry raising. A successful poultryman must have two types of characteristics: (a) natural, and (b) acquired.

Chief among the natural characteristics are love of the business, initiative and ability to work, and good judgment. One must like poultry in order to succeed, for the birds are very susceptible to the feelings of the person caring for them. As in other productive occupations, one must be willing to work and have the physical ability to work skillfully. Initiative in the poultry business is especially important, since the poultryman must constantly observe the birds, watch his accounts, and otherwise study his business, being ready at all times to plan new improvements. As poultry respond to the feelings of their keeper, so the person in charge must be quick to understand the birds. Such "chicken sense" constitutes good judgment in caring for and managing the flock.

The chief acquired characteristics are knowledge and skill in conducting the business. These abilities can be acquired only through training and experience. The young man who is anxious to enter the poultry business will find that time and effort spent in acquiring training in poultry farming constitute an excellent investment. To be able to perform the work skillfully, a man must have experience. If he can get this experience with the help of an instructor or a successful poultryman, he will be saved many expensive mistakes. Another very necessary qualification is a knowledge of the business methods commonly practiced. The poultryman must know how to deal with people, how to be courteous, prompt, tactful, and must at all times be honest and ambitious to build a reputation for himself.

Poultry farming is not an easy business. It is, however, a worthwhile occupation. It requires an alert, keen mind and a willingness to work hard with mind and body.

2. The labor problem

Securing and keeping competent help are the most difficult problems for the poultryman to solve. On a small plant, the operator can do most of the work and may employ help from time to time as needed. He may find help that is interested and intelligent, whom he can train to take more responsibility and thus relieve himself or the other help for outside work. When the plant is not large enough to support two men, or if too small for even one full-time person, an arrangement of this sort may permit one or both men to work the plant or ranch on a part-time basis. On a large plant the operator must employ men competent to perform part or all of the skilled work for him.

Also, skilled labor is constantly seeking an opportunity to go in business for itself. A plant must have a large business or be quite diversified, or both, to meet the necessary financial obligations.

3. The necessary cash and credit

As in most productive enterprises the poultryman needs both cash and credit. The amount of each required will be determined by the method of starting in the business, the size of the enterprise, the efficiency of the plant, and the financial standing of the operator in the neighborhood.

If a place is rented, less ready cash will be needed than if a

plant were purchased, unless many new buildings or much equipment is necessary. Credit for the poultry enterprise is often impaired by the lack of public confidence in the poultry business. This is a serious handicap. Without doubt, the lack of confidence is due to the large number of persons without experience who have entered the business and failed.

A sound method of starting a poultry business is to begin with a small plant and build up gradually. One should determine in advance the amount of cash and credit needed and the amount which he has available. For the beginner, it is well to reserve approximately one-half of the funds for working capital, leaving the remainder as fixed capital invested in land, buildings, and equipment. The business may be enlarged as the net earnings increase.

4. Limitations of the business

Many years of practice and observation have shown that there are several conditions which serve to limit or handicap the poultryman. One should be familiar with these in order to profit by the experience and study of others. These limiting factors are:

- (1) Small size of the individual fowl.
- (2) Short life of the individual fowl.
- (3) Small value per individual unit.
- (4) Hazards from diseases and parasites, and costs of control.
- (5) Dangers from stealing.
- (6) Dangers from fire.
- (7) Problems in marketing.

The small size of the fowl, together with the large number of birds in the flock and the small value of each, makes it very easy to lose sight of the individual. Disease may progress unobserved more easily than with larger animals. Thus, risks and losses are greater. One needs to take time to observe individuals. Individuals may disappear from a flock, especially in large flocks, and the loss may not be discovered until the fowls are counted.

Because of the short normal life of the fowl, there is rapid depreciation of stock, which requires frequent renewal. Poultrymen must therefore take the risk from year to year in hazards of brooding and rearing and sometimes incubation.

Egg production cannot be absolutely controlled, since it is a reproductive process, but great strides have been made in this

direction. Illumination, season of hatching, improvements in incubation, brooding, feeding, housing, and disease control are at present the best-known aids in the control of egg production. The proper use of these, coupled with correct breeding, secures good production and quite satisfactory hatches throughout the year.

The fertility and hatchability of eggs and the strength of the young stock depend on the vitality of the breeding flock and feeding and mating methods. Severe climatic conditions or wrong handling prior to or during the breeding season may give unsatisfactory results.

Both young and old stock are susceptible to diseases and parasites because of their small size and the mass method of management practiced. The young are becoming more vigorous but may fall easy prey to predatory animals and diseases. Mature stock resists many diseases but is easily thrown out of condition by mismanagement, which renders it susceptible to various troubles. New forms of diseases are constantly preying upon the flock, requiring individual handling, vaccinations, and trips to poultry disease laboratories. *Diseases and parasites are sometimes stimulated by man's mistakes in methods of management.*

Many poultrymen are handicapped by thieves. There is a popular idea that the "chicken thief" is not a serious malefactor. When we consider that the loss of mature individuals represents an entire season's work and money, we begin to realize the seriousness of this crime. Poultrymen may also sustain large losses by fire. The use of incubators and brooders increases the fire hazard. The risk is small, but fire occasionally occurs.

The vast number of eggs which must be graded to color, size, and shape, the loss from breakage and inferior interior quality, and market price fluctuations constitute vital problems in marketing. To succeed, the poultryman must understand both production and marketing problems. Unless one can market successfully, it is of little avail to produce.

5. Special advantages of the business

The following constitute the more important advantages of the poultry business:

- (1) The money value of poultry and eggs as human food.
- (2) The efficiency of poultry in multiplying and producing human food.

- (3) The maintenance of soil fertility.
- (4) Attractiveness as a business and homemaking occupation.
- (5) Adaptability to many types of farming and poultry management plans for increasing income.
- (6) Superior marketing advantages.
- (7) Available knowledge as a basis for successful methods.

The egg is the most universally used of any animal product except milk. It is a staple commodity for which there is no substitute. The egg is essentially liquid meat, being one of the most easily digested and assimilated forms of animal food; it also is one of the richest in growth-promoting vitamins.

The quick growth of the fowl, its early laying maturity, heavy laying, and natural vitality to resist disease offset the handicaps of short life, small size, and the low money value per individual. The birds' self-reliance and flocking instincts make it possible for large flocks to be brooded, housed, and fed together, and also make possible large poultry enterprises. The fact that poultry are natural foragers enables farm flocks to get much of their living from food which otherwise would be wasted. Furthermore, the addition of poultry manure and litter to the soil constitutes an excellent method of improving fertility, since these materials contain considerable quantities of nitrogen, phosphorus, potash, lime, and humus.

From the standpoint of the attractiveness of the poultry business, it is to be noted that relatively small amounts of capital and land are required and that there is a quick turnover of capital. Also, with good care and management, the business may be made profitable. Like other farming occupations, it is a healthful vocation.

In considering adaptability to persons and types of farming, it is significant that poultry is found on about 80 per cent of the farms of this country. Without doubt, poultry is kept in conjunction with other types of farming more than any other kind of livestock. This is because poultry provides the table with eggs and meat and furnishes an income throughout the year. Domestic fowls suffer less under close confinement than other kinds of animals, and therefore may be kept on small village lots. Because poultry keeping does not require as heavy manual labor as most other kinds of farming, this enterprise serves to interest many women and children on farms and in villages.

All kinds of poultry are efficient transformers of raw materials

into high-priced finished products. The domestic fowl, for example, transforms about 90 to 100 pounds of grain and mash, $\frac{3}{4}$ pound of oyster shell and grit, and 50 gallons of water into approximately 25 pounds of eggs yearly, besides maintaining the body. It is a great advantage to many persons to be able to ship concentrated commodities to market. This the poultryman is able to do.

Because eggs may be held, under favorable conditions, without cold storage for several days, it is not usually necessary to ship to market more than once or twice a week. Also, poultry may be held, killed, and shipped as the market requires. This is an advantage as compared with the production of highly perishable products, which must be shipped daily.

The egg is sold in its original package, the flavor and odor being concealed. The shell container prevents the quality from being known to many consumers until the egg is used, thus placing a premium on superior-quality products. Producers who have established a reputation for high-quality eggs frequently receive several cents per dozen over the highest market quotations. The fact that eggs and poultry may be preserved in storage for several months exercises a stabilizing influence upon prices. While storage eggs and poultry are not equal to the fresh product, consumers are provided a year-round supply at much lower prices than would be possible without storage, and the producer is accorded a higher seasonal price.

Preservation by breaking out and freezing whole eggs, or whites and yolks in any combination, has increased tremendously in recent years. This product is in demand by bakers and others.

Some eggs are dried for commercial and home use.

6. Methods of getting started in the business

"What is the best way for me to start?" is a most natural question for a person desiring to enter the poultry business. The answer depends upon the individual, and upon his available cash, experience, and special opportunities at the time. Education, experience, and capital usually present the most difficult problems for the beginner.

For the following five usual methods of entering the poultry business, the amount of cash and experience necessary increases in the order named: (1) working for salary for owner or operator; (2) working for salary with percentage of the profits; (3) cash rent; (4) partnership; (5) buying outright.



Fig. 103. A modern poultry farm layout. Note spacious lying house, permanent brooder, and ample tearing range.

Salary. This method is usually employed when one desires to accumulate money or experience to start for himself. If the plant is up to date, this constitutes an excellent opportunity for the employee to learn while the employer assumes the risks. One is likely to learn in direct proportion to the extent to which he does all kinds of work and studies the business. This method permits the beginner to gain in maturity and judgment before making a permanent investment for himself.

Salary with percentage of profits. This method is most advantageous when one is in charge of production and selling, since such an arrangement is satisfactory to both employer and workman. The salary acts as insurance for the laborer, and sharing in the percentage profits induces him to work for high yield and good prices, which, of course, the employer is anxious to have. A bonus on the number of chicks reared or of eggs produced frequently is a satisfactory plan.

Cash rent. This is desirable if the tenant knows his business and can produce successfully and market efficiently. The tenant assumes the risk of failure. The better the prospect is for making profit, the greater is the advantage to the cash renter. The simplest procedure in determining a fair rent is to inventory the buildings, equipment, and stock that are provided by the landlord. The rent should be at least 5 per cent of this investment and should also cover taxes, insurance, and depreciation, which the landlord usually assumes. (See inventory values, pages 232, 243.) It is better for the tenant to buy all stock. When the landlord provides part of the stock, the rent is higher because of the increased risk. A long lease of 3 to 5 years is better for both landlord and tenant.

Partnership. This is the fairest form of a share lease. Dean W. I. Myers, of Cornell University, suggests that the general plan of such a lease might be that all going expenses of the poultry enterprise and of maintaining the buildings should be paid out of receipts. After this a stipulated salary should be paid the tenant for his work, and then interest should be paid the landlord on his investment. Anything remaining above these items should be divided equally. Such an agreement has the advantage of taking the guesswork out of the lease, since all receipts and costs would be shared equally by both parties.

Many complications may develop in poultry-farming partnerships, primarily because of the fact that home as well as business

relations are involved. All partnership agreements should be in writing.

Buying outright. This is the ideal method for those who have sufficient education, experience, and capital to justify it. Risk is assumed entirely by the owner, and changes in the plant and management may be made at his discretion. The beneficial effect of the pride of ownership is one of the most important elements in this method. One usually takes most interest and pride in the results of his own handiwork.

Community Survey

Ask one or more poultrymen who started with a small business in your neighborhood to give you the following details.

1. When they started with poultry.
2. What problems appear to give the greatest difficulty in establishing and building up a poultry plant and business.
3. How the labor problem has been handled.
4. Whether or not it has been difficult to secure and keep competent labor.
5. Which one of the several ways of starting in poultry work these poultrymen would recommend.
6. What troubles they have experienced with the stock, and how they have learned to combat and prevent these troubles.

DIRECTIONS FOR A STUDY OF THE LOCATION AND LAYOUT OF A POULTRY PLANT

Farmers who make poultry raising their major enterprise find that special buildings, equipment, and layout are needed in order to make the business profitable. For students or farmers who contemplate taking up a specialized type of poultry farming, there is no better means of preparation than to study the practices of successful men in the region. Several hours spent in studying their plants and interviewing them will yield valuable returns to the student. He may profit by their successes and failures. In most communities, there are one or more farmers who are practicing poultry farming on an extensive scale. Visit several of these farms and ask for an interview with the operator. Equip yourself with notebook and pencil, observe the following points, and secure the suggested information from the farmers.

Observations on the plant:

1. Sketch the layout of the plant. Is it located on good roads?
2. Note the location of the following buildings:
 - (a) Laying or breeding houses.
 - (b) Brooder houses.

- (c) Range shelters.
 - (d) Bachelors' hall.
 - (e) Crematory or disposal pit.
 - (f) Barracks shelters.
 - (g) Service building.
 - (h) Incubator building.
 - (i) Manure shed.
 - (j) Storage building.
3. Are the buildings located so as to conserve the time and effort of the operator?
 4. Is electricity available? Are the buildings adequately wired?
 5. What system of housing is used?
 - (a) Colony system?
 - (b) Continuous single-story house system?
 - (c) Multiple-story?
 6. What system of rearing is used?
 - (a) Range?
 - (b) Confinement?
 - (c) Confinement and outside wire floors?
 7. If confinement, when are pullets transferred to laying quarters?
 8. Where are the old layers moved to make room?
 9. How much range is allowed for young stock?
 10. What is the character of the range for growing stock?
 11. What system of fencing is used?
 12. Is the range cultivated?
 13. Does the range provide shade and green growth? What is its soil type? Are specially prepared pastures provided?
 - (a) What seed mixtures are used?
 - (b) What care is given the pasture during the growing season?
 14. In what directions do the buildings face?
 15. Are the buildings protected by natural windbreaks?
 16. Is the air drainage good?
 17. What natural advantages are there which favor the location of the building?
 18. What is the nature of the water supply? Is it adequate the year around? Is water piped to the places where needed?

Data to be secured from farmers or other sources:

1. Secure the following information. These data will be serviceable in determining the regions adapted for poultry farming.
 - (a) Seasonal temperature, maximum and minimum.
 - (b) Seasonal rainfall, maximum and minimum.
 - (c) Sunshine, maximum and minimum.
 - (d) Direction and force of prevailing winds.
 - (e) Principal markets.
 - (f) Distance from market.
 - (g) Population of the nearby markets.
 - (h) Distance from the local station.

- (i) Express or truck rate on eggs, dressed poultry, live poultry.
 - (j) Freight or truck rate per ton of feed.
 - (k) Passenger rate to the market.
 - (l) Frequency of train or truck service to the market.
 - (m) Hours for shipments to reach the market.
 - (n) Are cooperative egg markets available?
 - (o) What is their nature?
 - (p) What are their advantages?
 - (q) Condition of the roads in the neighborhood during bad weather.
 - (r) How are the roads kept in repair?
 - (s) What are the educational advantages in the community?
 - (t) What are the religious advantages in the community?
 - (u) What are the social advantages in the community?
 - (v) What can be said of the character, progressiveness, and prosperity of the people of the community?
 - (w) What organizations are in operation—Grange, clubs, associations, service clubs?
 - (z) Is bus service available?
 - (y) What is the cost per year for telephones?
2. What do you consider the advantages of a colony system of housing mature stock?
- (a) Is there less danger from fire?
 - (b) Is there less trouble from disease carried from flock to flock?
 - (c) Is the original cost greater?
 - (d) Is the labor cost higher?
 - (e) Are the houses cold?
 - (f) Are the colony houses more convenient?
3. What do you consider the advantages of a single-story continuous system of housing mature stock? Of the multiple-story house?
- (a) Is it cheaper per bird to construct?
 - (b) Is the operation cost less for labor?
 - (c) Are the houses better protected from the weather?
4. What influences do the following have on the location of the laying and breeding house?
- (a) Range.
 - (b) Accessibility.
 - (c) Exposure.
 - (d) Protection
 - (e) Air drainage.
 - (f) Safety.
5. In the following list, check the uses made of the service building:
- (a) Feed storage and mixing.
 - (b) Work shop
 - (c) Egg room for candling and packing.
 - (d) Killing and picking.
 - (e) Incubation room.
 - (f) Office.
 - (g) Storage for crates, supplies, and equipment.
6. Why did you select this location for a poultry farm?

7. In what order were the buildings constructed or remodeled? What buildings were on the place when you acquired it?
8. What do you regard as the advertising value of this location?
9. Do you contemplate enlarging the plant and layout? If so, how and why?
10. What are the nationality and attitude of the neighbors?
11. Have you installed soil drainage?
12. What crops do you grow? Area of each?
13. Would it be advantageous to have more land and grow more crops?

References

- Darrah, L. B., and J. H. Bruckner, "Getting Started in Poultry Farming," *Cornell Ext. Bull.* 679, Cornell Univ., Ithaca, N. Y., August 1945.
- Hart, V. B., "Suggestions to Persons Who Plan to Farm or to Live in the Country," *Cornell Ext. Bull.* 652, Cornell Univ., Ithaca, N. Y., June 1944.

Anatomy and Physiology of the Domestic Fowl

It is human nature to desire to take things apart and see how they are made. The poultryman is fortunate in being able to satisfy this desire, since a chicken, which is a small individual, and usually one of a large number, may be killed, examined, and later used for food. In this way no loss is occasioned, while some interesting and valuable information may be obtained. Some knowledge of the anatomy of the fowl and of the functions of the various parts, and their relation and importance to many recognized practices of poultry management, is of practical value to the poultryman. Moreover, the division of labor among the various organs and the intricate interlocking and relationship of the many muscles, bones, blood vessels, etc., furnish a most amazing example of the coordination of parts and functions.

Operations:

Studying various parts of the bird's body, as follows:

1. A feather.
2. The feather tracts.
3. The head
4. The brain
5. The muscular system
6. The respiratory system.
7. The circulatory system.
8. The digestive system
9. The reproductive system.
10. The excretory system.
11. The skeletal system.

1. A feather

All feathers are formed on the same general principle, but they differ in size, shape, and rigidity. (See Fig. 197.) A large feather is most easily studied. Secure a primary or secondary feather from the wing, or one of the stiff, main tail feathers, and find the following parts.

The stem. This is the main part of the feather and consists of two parts, the quill and the shaft.

The quill. This is cylindrical and hollow, and makes up the base of the feather. It is filled with a parchmentlike material called pulp. In new feathers the quill is filled with blood. This fact is used to determine whether or not a hen has new feathers.

The shaft. The remaining part of the stem is called the shaft. It is grooved on the underside, and therefore has great strength in proportion to its weight.

The vane. This comprises the shaft and the barbs attached to it on both sides. It provides a wide, tight, flat surface for protection to the body and for use in flight.

The barbs. The long, slender parts projecting at right angles to and from either side of the shaft are called barbs. The barbs and their barbules are sometimes referred to as the web of the feather. The barbs may be easily seen and appear to be stuck together.

The barbules. Along the sides of the barbs, and at right angles to them, are smaller processes called barbules, which bear hooklets or barbicels. These hooklets hold the adjacent barbs together and are responsible for the resistance offered when the barbs are separated.

The inferior umbilicus. This is a small hole in the lower end of the quill, through which the blood enters to nourish the feather.

The superior umbilicus. This name is given to a small opening

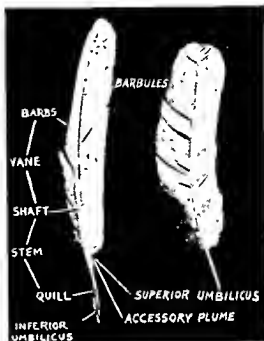


FIG. 197. Parts of a feather.

at the junction of the quill and shaft at the point where the quill emerges from the skin. The superior umbilicus connects the interior of the quill with the outside air.

The accessory plume. A small growth, which in some cases resembles a feather and in other cases is rudimentary and consists merely of down, is attached to the underside of the feather at the base of the shaft. This growth is called the accessory plume. It partly covers the superior umbilicus. It appears only on old feathers, and hence serves a useful purpose in distinguishing old feathers from the new.

2. The feather tracts

In several sections of the body, the feathers are developed in compact formations extending over definite areas. These areas may best be seen by killing a fowl and studying the skin. The feather tracts are indicated by raised portions of the skin on which are the scars, or feather follicles. The feather tracts are located where they provide the greatest protection to the body.

When dry-picking poultry for market, the feathers on the feather tracts should be removed promptly, since tearing is likely to occur if the skin cools (Chapter 11).

Observe the following feather tracts.

The ventral tract. This extends the entire length of the body on the underside, passing from the head along the neck to the breast, where it divides and passes on either side of the keel bone to the vent. Throughout the greater part of its length, it is separated from the spinal feather tract by featherless spaces, one on either side of the trunk and neck (Fig. 198).

The femoral tract. This is a triangular tract of considerable size, on the thigh (Fig. 198).

The humeral tract. On the upper arm of the wing, and close to the back, this narrow strip runs crosswise of the wing. The wing coverts grow in the humeral tract.

The ventral, femoral, and humeral tracts are those most likely to tear in the process of dry-picking. There are other tracts of somewhat minor importance.

3. The head

An examination of the external head (Fig. 199) reveals the following parts.

The upper and lower mandibles. These form the beak, and are especially designed for picking up, sorting over, or tearing food.

Two nostrils. These are oblique slits, one on either side of the upper beak, opening into the roof of the mouth through the elef.

The eyes. Each eye has three lids. (1) The upper and (2) the lower lids are easily seen. The upper lid moves slightly; the lower lid moves upward, covering almost the entire eye when closed. .

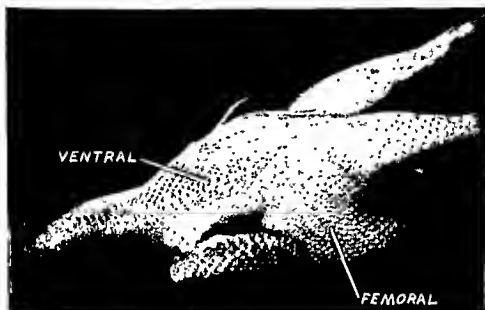


FIG. 19S. The feather tracts.

(3) The inner or third lid is a white membrane, which moves with great rapidity and diagonally across the eye, starting from the upper front section of the eye socket.

Hold a live bird quietly and, with the tip of a soft feather, carefully touch the eyeball. The inner lid will quickly pass over the eyeball.

On a dead bird, this lid is seen as a whitish material in the corner of the eye. With a peneil point it may be moved out and across the eye.

The ear opening. This opening is covered for protection by a cluster of small, stiff feathers. It lies behind and slightly below the eye.

The comb. The fleshy growth at the top of the head is called the comb. Like the earlobes and wattles, it is a secondary sexual character, the function of which appears to be sex attraction.

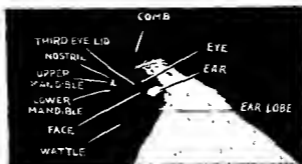


FIG. 199. The head.

The earlobes. These are the oval fleshy growths on the face, back of and below the ear openings.

The wattles. These are attached to the underside of the throat and the lower beak.

The face. All the fleshy, nearly featherless area around the eye is included in the face.

4. The brain

In order to study the location of the more important parts of the brain (Fig. 200), remove the comb and skin from the top of the head and, with a heavy, sharp knife and a hammer, cut through the center of the head lengthwise. If the cut is made directly through the middle, the brain should be easily seen.



FIG. 200. The brain Longitudinal section of the head of a high-producing White Leghorn hen.

A satisfactory way is to freeze the head, then halve it with a fine saw.

The cerebrum. This is a large, bilobed section of the brain, light gray in color, lying in the upper part of the skull, next to the eye socket. It is somewhat heart-shaped.

The cerebellum. This is an oval body, light gray colored, lying just below and back of the cerebrum. When the cerebellum is cut lengthwise, the inner cut surface shows several whitish lines radiating from a whitish center.

The medulla oblongata. This is the rather thick, wide, white body lying just under the cerebellum and attached to the upper end of the spinal cord. It is the connecting link between the other parts of the brain and the spinal cord; through the cord, it connects the brain with the rest of the body.

Either the cerebellum or the medulla must be pierced with the knife when the stick for dry-picking is made, in order to make the muscles relax their grip on the feathers. Piercing the cerebrum will kill the bird, but will not loosen the feathers.

Place a knife on the half of the head, and observe that the point must be directed low down at the base of the skull if the proper result is to be secured when sticking for dry-picking (see Chapter 11).

5. The muscular system

With a sharp knife or scalpel, cut through the skin from the corner of the mouth down the side of the neck, and along the keel to the vent. Remove the skin from one side of the bird, from the keel to the middle of the back. Use the fingers as much as possible while doing this, and do not cut the flesh. Several important muscles should now be seen.*

The major pectoralis. This is the large breast muscle used to pull the wing down in flight. It reaches from the rear of the keel down and over the wishbone. Start at the base of the keel and, with the fingers, loosen this large muscle (Fig. 201). It lies on, but is separated from, a muscle just beneath.

The minor pectoralis. This is located below the major, and is used to raise the wing in flight. It lies in the angle formed at the junction of the keel with the body skeleton (Fig. 201).

*For a more complete discussion of the many muscles comprising the bird's body, see *Anatomy of the Domestic Fowl* by Kaupp.

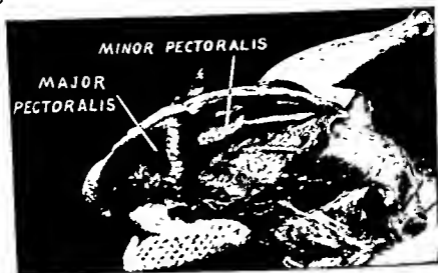


FIG. 201. The breast muscles.

The biceps. The muscle located on the inside of the humerus or upper arm, used in closing the wing, is called the biceps.

The triceps. This is a muscle located in the upper arm, on the outside of the humerus. It opens and spreads the wing, its action being the reverse of that of the biceps.

The gastrocnemius. The large muscle at the rear of the tibia, or drumstick, is the gastrocnemius. It is larger at the upper end. It raises the tibia and extends the shank, or metatarsus.

On the front of the drumstick are several muscles and tendons which move the shank and toes.

By carefully removing the large outer muscle of the thigh and drumstick, other muscles and tendons will be observed. Their uses can be studied by pulling on them and noting the action of the leg and toes. Note the way the bending of the leg when the bird is at rest on the roost causes the toes to grip the perch, thus preventing falling.

6. The respiratory system

Remove the sternum or breastbone (Fig. 138). Insert the knife under the skin near the breast, and run it up the neck. Lay the skin back on the neck, thus exposing the windpipe and the esophagus, or food pipe. The head has already been split to facilitate the study of the brain.

The respiratory system may now be seen, and may be traced from the nostril through to the lungs. The respiratory system,

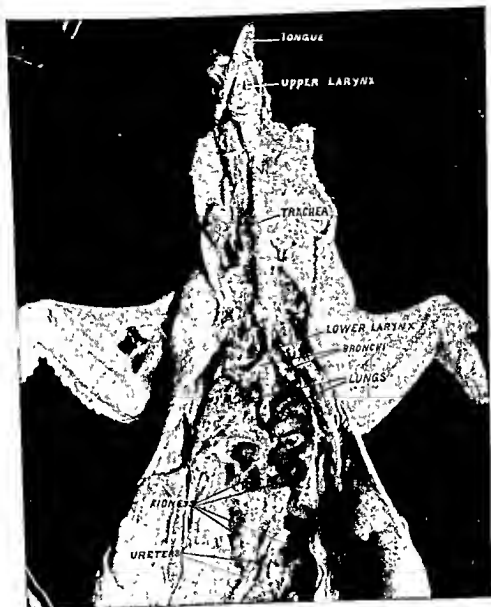


FIG. 202. The excretory and respiratory systems.

starting from the nostril, consists of (a) nostrils, (b) pharynx, (c) upper larynx, (d) trachea, (e) lower larynx, (f) bronchi, (g) bronchial tubes, (h) lungs, and (i) air sacs (Fig. 202).

The nostrils. Examine the nostrils and the nasal chambers, and observe their proximity to the eye.

The pharynx. The pharynx is the part of the roof of the mouth, at the rear, on which is a row of horny projections. It is located where the soft palate is found in other animals.

The upper larynx. This is the opening at the upper end of the trachea at the base of the tongue.

The trocheo. The trachea, or windpipe, is made up of cartilaginous and bonelike rings, connected by muscular tissue. It extends from the upper larynx to the lower larynx.

The lower lorynx. At the lower end of the trachea, the pipe divides; it is at this point that the lower larynx is located. The true organ of voice is contained in the lower larynx.

The bronchi. The lower trachea divides into two parts or tubes, one going to the right lung and the other to the left lung. These tubes, or bronchi, are provided with incomplete cartilaginous rings.

The bronchiol tubes. When the bronehi enter the lungs, they immediately change their form, and divide and subdivide, forming the bronchial tubes.

The lungs. The lungs are pinkish or reddish organs, one on either side of the body. They lie embedded between the ribs, extending downward from a point near the back. By carefully moving the internal organs near the front of the body cavity to one side, with the fingers, one may expose the lungs to view.

The air sacs. Roll a piece of paper or make a tube from a large quill, insert it into the trachea, and blow into it. If the air sacs have not been destroyed, one or more of the nine air sacs may be inflated.

These sacs communicate with the interior of the bones. Kaupp states that, while not communicating with one another, they are so formed that they may be partly inflated, thus making the body of birds lighter for flight.

7. The circulatory system

Carefully moving the organs near the heart, observe the arteries and veins which extend from the heart to various parts of the body.

The circulatory system of birds is very similar to that of mammals. The heart consists of two auricles and two ventricles. The impure blood passes from the right auricle to the right ventricle, and from there through the pulmonary arteries to the lungs. Purified blood returns to the left auricle through the pulmonary veins, and passes from the left auricle to the left ventricle, and from there through the aorta to the body. Impure blood returns to the right auricle, completing the cycle.

8. The digestive system

Carefully remove the entire digestive system (Fig. 203), starting at the mouth by loosening the tongue and the food pipe, or esopha-

gus, and then the crop. Then lift out the liver, gizzard, intestines, etc., after loosening them from the body walls. Finally, cut around the vent.

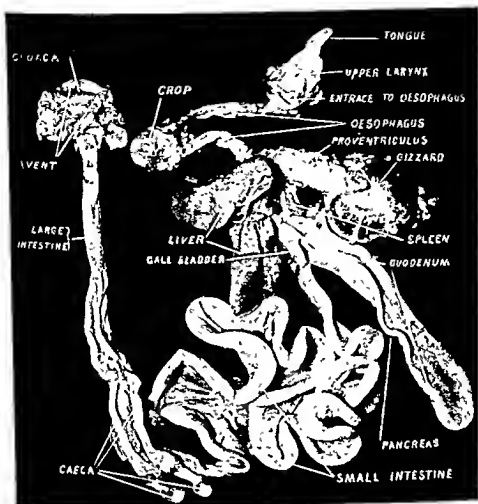


FIG. 203. The digestive system.

Lay the entire tract on the table and note the various organs. The following organs should be seen in order. It will be found interesting to measure the length of each section.

The tongue. The tongue is normally attached to the back part of the floor of the mouth.

The esophagus. This is the tube through which food travels from the mouth to the crop, and from the crop to the proventriculus.

The crop. The crop is an enlargement of the esophagus, and is used for storing and softening the food. Food is gradually sent along to the stomach as needed, by contraction of the walls of the crop.

The proventriculus. Two or 3 inches beyond the crop, an enlarged muscular portion of the esophagus will be seen, about $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter and from $1\frac{1}{4}$ to 2 inches long. This is the proventriculus. On the inner surface are the openings of various glands, which secrete gastric juice and some acids. These liquids are mixed with the food and assist in the further softening of it.

The gizzard. The gizzard is heavily muscled, reddish green in color, and located just back of the proventriculus. Probably some gastric digestion takes place in the gizzard, but this organ functions chiefly in crushing and grinding food. It is the largest single organ in the body.

The gizzard is a powerful muscle. It has been reported that iron tubes capable of supporting a weight of 535 pounds have been completely flattened out by passing through the gizzard of a turkey.

The duodenum. Leaving the gizzard, near the point at which it entered, the digestive canal continues, forming a fold immediately after it leaves the gizzard. This loop or fold of the intestine is the duodenum, which supports the pancreas.

Gastric digestion, together with some pancreatic digestion, takes place in the duodenum.

The pancreas. The pancreas is the long flesh-colored organ lying between the folds of the duodenum. It empties the pancreatic juice (a digestive juice) into the small intestine as food passes along the intestines. Food does not enter the pancreas.

The liver. This is a large, several-lobed, dark red organ. It is more or less flat, becoming quite thin at the extremities. It is the largest gland in the body. The liver secretes the bile, which aids in digestion. Food does not pass through the liver.

Sugar, in the form of glycogen, is stored in the liver by the blood, and uric acid is formed here and passed on to the urine.

The gall bladder. Partly embedded among the folds of the liver is an elongated greenish organ, the gall bladder. Some of the bile is stored in the gall bladder. Bile is a fluid which helps in the digestion of the fats contained in the food. A duct leads from the gall bladder to the upper end of the duodenum, where the bile aids in digestion as the food passes along the intestine.

The spleen. This round reddish body is found near the liver. It is usually from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter. Its function is little known. Some authorities believe that the white corpuscles of the blood are accumulated in the spleen and rebuilt or cast from the body. Food does not pass through the spleen.

The small intestine. The small intestine includes both the duodenum and the remaining portion of the digestive tube, from the gizzard to the caeca. It is about $2\frac{1}{2}$ feet long in the average bird. The inner surface is lined with minute villi, which may be seen by washing under water.

Pancreatic digestion, together with the emulsifying of fats by the bile, takes place in the upper end of the small intestine. Absorption, by the blood, of nutrients contained in the food mass takes place throughout the entire length.

The caeca. At the junction of the small and large intestines are two branches, 5 to 7 inches in length. These open into the intestine at one end, but have no outlet at the other.

Because of this, they are sometimes called "blind guts." Their function is not definitely known. They appear to serve as temporary storage organs for fecal material, and some absorption may take place in them.

The large intestine, or rectum. That part of the tract between the caeca and the cloaca corresponds to the large intestine in other animals, and is more commonly known as the rectum in poultry.

Kaupp states that digestion and absorption may continue in the large intestine.

The cloaca. The rectum terminates in a short, saclike organ, slightly larger in diameter. This is the cloaca, and it is here that the ureters deposit the urine from the kidneys. The urine and the solid waste material in the large intestine are mixed together in the cloaca. The oviduct of the female and the two vas deferens of the male also open into the cloaca.

The alimentary canal ends at the *vent*, which is the external orifice of the cloaca.

9. The reproductive system

In the female, the ovaries and oviduct may be seen after the digestive system is removed (Fig. 204). (See Chapter 24 for illustrations and description of the system and its function.) The reproductive system of the male includes the following organs (Fig. 205):

The testes. In the male, the two light-colored testes will be seen lying on either side of the backbone, near the center of the body.

The vas deferens. From the testes, the two vas deferens extend along the kidneys and to the outside of the ureter, finally ending



FIG. 201. Female reproductive system of a White Leghorn hen in heavy production.

in the upper wall of the cloaca. Their function is to carry the seminal fluid from the testes to the cloaca.

10. The excretory system

This system consists of the kidneys and the ureters (Fig. 202).

The kidneys are a pair of convoluted, three-lobed, dark red bodies, firmly embedded among the bones along the spine and extending from the lungs well to the rear.

The ureters are a pair of tubes connecting the kidneys with

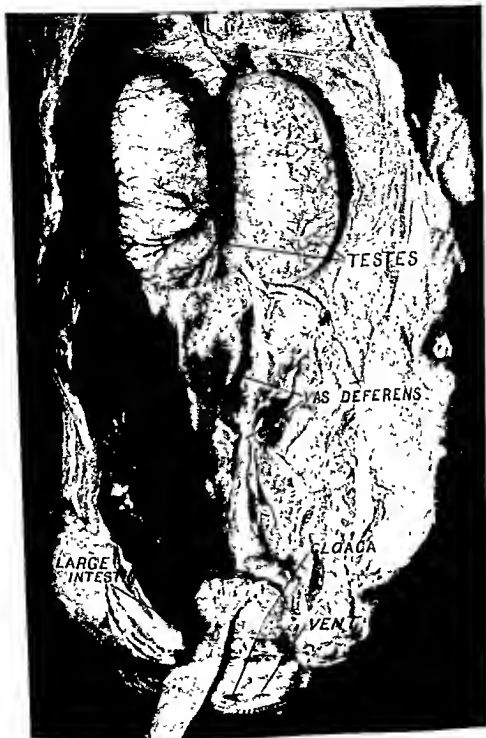


FIG. 205. Male reproductive system.

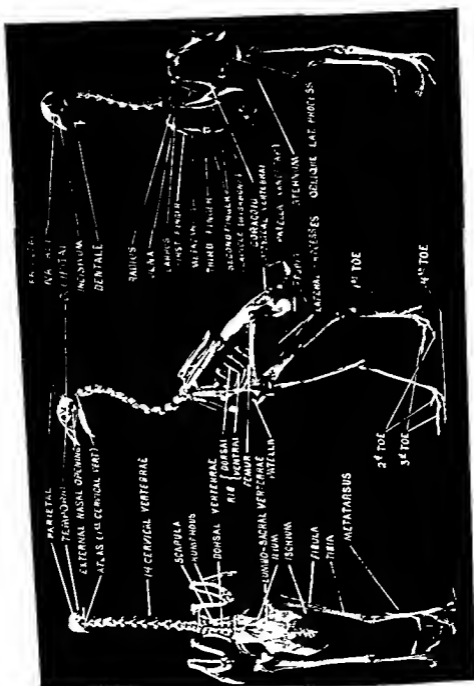


FIG. 200. Skeleton of the domestic fowl.

the lower part of the cloaca. The urine is passed through the ureters to the cloaca, where it is expelled with the feces. The white, chalklike deposit frequently seen in the voidings is due to urates, and is not, as sometimes believed, a deposit of lime.

11. The skeletal system

The structure of the bones of poultry is quite similar to that found in other animals, except that many of the bird's bones are hollow.

In the baby chick, many of the future bones are to a large extent cartilage, which becomes hardened into bone as the chick grows older. This fact is sometimes used in determining the age, as the

Table 34. Divisions of the Skeleton¹

The axial skeleton	Skull	{ Cranium	
		{ Face	
	Vertebral column	{ Cervical region	
		{ Dorsal region	{ Ribs
			{ Sternum
		{ Lumbar region	
		{ Sacral region	
		{ Coccygeal region	
The appendicular skeleton	Shoulder girdle	{ Scapula	
		{ Coracoid	
		{ Clavicle	
	Fore limb	{ Arm—Humerus	
		{ Forearm	{ Radius
			{ Ulna
		{ Hand	{ Carpus
			{ Metacarpus
		{ Phalanges	
	Pelvic girdle (hip bone)	{ Ilium	
		{ Ischium	
		{ Pubis	
	Hind limb	{ Thigh—Femur	
		{ Leg	{ Tibia
			{ Fibula
		{ Foot	{ Metatarsus
			{ Phalanges

¹ From B. F. Kaupp, *Anatomy of the Domestic Fowl*, W. B. Saunders Co.

rear end of the keel does not harden and may be bent until the bird is nearly a year old.

For names and location of the bones, see Fig. 206 and Table 34.

Secure a skeleton and identify the bones comprising the skeletal system by referring to the illustration.

References

Bradley, O. C., *The Structure of the Fowl*, Oliver & Boyd, London.

Kaupp, B. F., *Anatomy of the Domestic Fowl*, W. B. Saunders Co., Philadelphia.

Formation of the Egg and Chick

A knowledge of the means by which nature surrounds the developing embryo with the conditions necessary for its life and growth and of the manner in which the embryo responds to these conditions is essential in arriving at an understanding of the principles of incubation. It will add interest to the daily task of running the incubator to realize that the egg, although perhaps incubated miles away from the sire and dam that gave it life, contains within the shell in microscopic form the germ of life capable of producing a perfect chick when given the proper conditions for incubation.

General information:

1. Formation of the egg.
2. Structure of the egg.
3. Formation of the chick.

1. Formation of the egg

There are two parts of the hen's body that are chiefly concerned in the development of the egg, namely, the ovary and the oviduct (Figs. 207 and 208).

Growth of the yolk. The yolk of the egg is the first part to develop; its development takes place in the ovary, which is located close to the backbone of the fowl. The ovary contains many hundreds of minute yolks or ova or egg cells (Fig. 208). If a normal fowl is killed while in laying condition, these yolks are found in all stages of development. Each yolk is enclosed in a sac, or follicle, through which it obtains its nourishment while developing.

The yolk is gradually built up in the cell body of the egg cell by the addition of concentric layers of yellow yolk around an inner case of white yolk. The nutriment for these growing ova, or yolks,

is supplied by the hen from the products of her digested food, brought by the blood vessels to the cells in the follicles and transferred by them to the growing ova.



FIG 207. The ovary and oviduct of a hen in heavy production. Note the distinct suture lines with no blood vessels crossing, and the many folds of the oviduct packed away in a comparatively small space.

According to Lillie,* the yellow yolk is laid on daily in regular layers, separated by very thin strata of the white yolk.

"The principal accumulation of white yolk lies in a central flask-

* Lillie's *Development of the Chick*, Henry Holt & Co., New York, 1952.

shaped area, the latebra, which extends toward the germinal disk from the center of the yolk. This tube of white yolk flares out

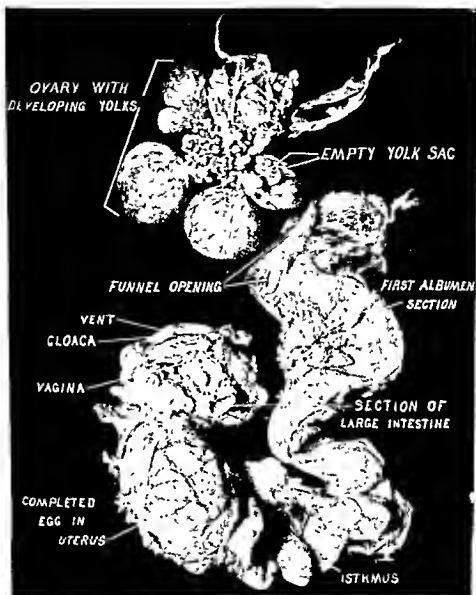


FIG. 208. The ovary and oviduct removed. Note the empty yolk sac split along the suture line, and the funnel opening of the oviduct into which the yolks drop.

under the germinal disk into a mass known as the nucleus of Pander." *

As the yellow yolk is laid on, the germinal disk moves gradually

* B. M. Patten, *Embryology of the Chick*, Blakiston Co., New York, 1952.

onward, always remaining close to the vitelline membrane, and leaving behind it the tube of white yolk, across which no yellow yolk is deposited (Fig. 103, Cross section of an egg).

At Cornell University, A. L. Romanoff* found that about 7 days are required for the full development of the yolk from its original minute size. The layers vary in thickness probably owing to the physical condition of the bird, rate of laying, and the like. When the yolk is mature, the germinal disk appears as a light-colored spot on the surface. This may be seen when an egg is carefully broken into a saucer.

Yolk released at maturity. When the yolk becomes mature, the yolk sac splits along the suture line and allows the yolk, enclosed in its vitelline membranes, to drop into the body cavity. There the funnel-shaped opening of the oviduct (the *infundibulum*) envelops the yolk, and its passage through the oviduct begins. (Figs. 207 and 208).

As soon as the yolk escapes from its yolk sac, the sac contracts and usually remains as unabsorbed tissue, although so much decreased in size that it is difficult to distinguish the yolk sac after a few weeks.

The magnum. As the yolk continues its passage, the various glands lining the oviduct secrete the *albumen*. About 40 per cent of the albumen, or white, of the egg is laid on as the yolk passes down through the upper half of the oviduct, which is the *magnum* (Fig. 208).

The time occupied in passing through the magnum is about 3 hours.

The first albumen to be deposited on the yolk is the very thin layer of dense albumen close to the vitelline membrane and continuous with the chalazae. Next to the dense inner layer there is a layer of inner thin, surrounded by a thicker middle layer (Fig. 103).

The isthmus. After the yolk has reached the halfway point in its progress down the oviduct, it enters the isthmus (Fig. 208), where the shell membranes and 10 to 20 per cent more albumen are added. By this time the egg is beginning to assume its final size and shape. About 3 hours are required for the passage through the isthmus.

The uterus. The uterus is the next portion of the oviduct into

* A. L. Romanoff, "Growth of Fowl's Ovary," *Biochem. J.*, Vol. XXV, No. 4 (1931).

which the developing egg passes. Here the remainder of the albumen is drawn in through the shell membranes. The shell is also deposited in this section. The shell pigment and the outer gelatinous coating of the shell (the bloom) are added here.* The egg is ordinarily laid from 12 to 24 hours after it enters the uterus.

The vagina. The egg then passes through the vagina into the cloaca.

The cloaca. The completed egg is now ready for expulsion through the vent.

2. Structure of the egg

In the cross section of an egg shown in Fig. 103, the various parts may be seen. Many of these parts may also be seen in a hard-boiled egg that has been cut in half longitudinally.

The layers of light-yellow yolk and the tube of white yolk may often be observed.

The chalazae and the four layers of albumen can best be seen by opening a fresh egg into a saucer. The chalazae are attached to the inner firm albumen layer surrounding the yolk and are on opposite sides of the yolk. They extend out into the outer firm albumen and toward the ends of the egg. A chalaza consists of a white, fibrous thread of albumen. The size and density of the chalazae vary in different eggs.

The chalazae prevent any rapid change in the position of the yolk, and cause the yolk to revolve on the long axis of the egg, keeping the germinal disk on the upper side, nearest the heat from the hen's body during natural incubation. The chalazae act as a drag or anchor in preventing the yolk from rising too fast, and during incubation they keep the germinal disk and the embryo from sticking to the shell.

The inner firm layer of albumen surrounding the yolk is transparent. The outer firm layer, very evident in the broken-out egg, largely influences the quality of the egg. Cutting the outer firm releases an inner thin layer of albumen.

The inner and outer shell membranes consist of a network of organic fibers, the inner one being of finer texture.

The shell consists of three layers: the mammila, next to the

* A. L. Romanoff and Anastasia J. Romanoff, *The Avian Egg*, John Wiley & Sons, New York, 1919.

shell membranes; the spongy or outer layer, in which the pigments derived from the blood are found; and the gelatinous outside layer, or bloom.

When the egg is laid, the shell is completely filled; but after cooling, the contents contract and an air space is formed between the two shell membranes, usually at the large end of the egg.

3. Formation of the chick*

The several stages in the formation of the chick are briefly described in the following paragraphs.

Fertilization. Through copulation with the male, countless numbers of spermatozoa are emptied into the oviduct of the hen. These spermatozoa make their way along the oviduct to the upper end. They will remain alive and fertilize eggs for 2 or 3 weeks after copulation.

Fertilization takes place in the upper end of the oviduct, just after the yolk passes into the funnel-shaped end of the oviduct and before any albumen is laid on (Fig. 208). In order that fertilization may occur, the nucleus of the female cell must fuse with the nucleus of the male cell. The female nucleus is located in the germinal disk, and the male nucleus is in the head of the spermatozoon.

From six to twenty-four sperm cells penetrate the germinal disk, but only one enters the egg cell and fertilizes the egg.

Nature has many devices for preventing the entrance of more than one sperm cell. Before fertilization, the sperms are attracted, but after one has entered and fertilized the nucleus the other sperms are repelled. The exact means employed for repelling the sperm cells is unknown.

As soon as the fertilization of the two nuclei is accomplished, the development of the embryo begins; and as the yolk passes down the oviduct, gathering albumen, on its way to the cloaca, the division of cells proceeds.

Cleavage (Fig. 209). The first division of cells occurs immediately after fertilization. This division is called cleavage.

The cells form on the germinal disk. The two fused cells divide and form two cells, each with part of the nuclear material. Each

*This description was gleaned from notes taken by H. E. Botsford from lectures by Dr Kingsbury of the Medical College, Cornell University. Patten's *Embryology of the Chick* was also freely consulted.

of these cells again divides at right angles to the first division, making four cells. After this, each cell continues to divide and the number of cells is increased very rapidly. This group of cells in the germinal disk is called the blastoderm. The cells of the blastoderm are smaller in the center of the group and somewhat larger at the outside.

The blastula stage. The blastoderm, by the rapid formation of the new cells, is raised slightly in the center, forming a cavity between the yolk and the blastoderm (Fig. 210). This cavity is the blastocele, or segmentation cavity.

The blastoderm touches the yolk on all sides. The outer part of the blastoderm, which remains on the yolk, is termed the area opaca. The central part, which is raised from the yolk, is called the area pellucida.

The layer of cells as it exists at this stage is called the blastula.

The gastrulation stage (Fig. 210). The blastoderm might be likened to a pancake lying flat on the surface of a large ball. The space between the yolk and the edge of the blastoderm is called the blastopore. Two so-called germ layers are now formed, the upper surface of the blastoderm being the ectoderm, and the lower the entoderm.

The blastopore section is the rear of the embryo as it continues to develop.

The cells of the blastoderm continue to develop, spreading out over the yolk. The sides continue to grow out and around until they come together behind the opening, or blastopore.

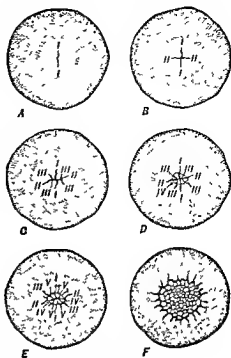


FIG. 209 Cleavage. Surface aspect of blastoderm at various stages of cleavage. Based on Blount's photomicrographs of the pigeon's egg. The blastoderm and the immediately surrounding yolk are viewed directly from the animal pole, the shell and albumen having been removed. The order in which the cleavage furrows have appeared is indicated on the diagrams by Roman numerals. A, First cleavage; B, second cleavage; C, third cleavage; D, fourth cleavage; E, fifth cleavage; F, early morula. From Patten's *Embryology of the Chick*.

The stages described above are passed through before the egg is laid, and while it is passing down the oviduct to the cloaca. Up to this point, development is very slow. The embryo is so minute that all that can be seen with the naked eye is a slightly enlarged germinal disk, and possibly what may appear to be one or two rings of somewhat darker or lighter material on the disk.

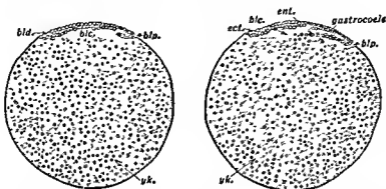


FIG. 210. Gastrulation in form with telolecithal egg containing large amount of yolk—birds. Schematic diagrams to show the effect of yolk on gastrulation. Abbreviations: *blc*, blastocoel; *bld.*, blastoderm; *blp.*, blastopore; *ect.*, ectoderm; *ent.*, entoderm. From Patten's *Embryology of the Chick*.

First day of incubation. By the time the egg is laid, only a few hours of incubation are necessary before a streak known as the primitive streak is formed.

The growth of the embryo takes place at the front of the primitive streak (Fig. 211), the various parts growing out of it or coming from the space it has occupied. The primitive streak remains at the rear of the embryo throughout the development and finally becomes the tail bud (Fig. 211, right).

The growth developing out of the primitive streak may be compared to a stick which is drawn through the water. The ripples and waves grow out from the place where the stick has been. In a similar way, the embryo develops just ahead of the primitive streak.

The mesoderm. We have spoken of two germ layers, ectoderm and entoderm. A third germ layer (mesoderm) soon develops. From either side of the primitive streak, the mesoderm grows out as a sheet of tissue inserted between the ectoderm and the entoderm. (Fig. 212.)

This completes the three germ layers characteristic of all verte-

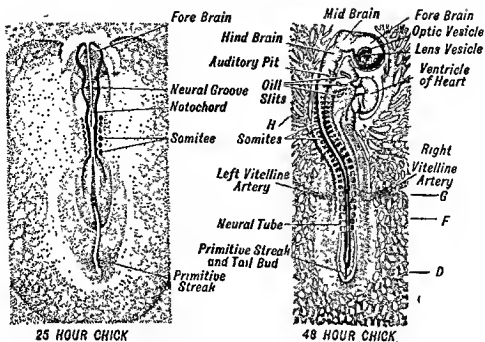


FIG. 211. Note the rapidity of growth and large size at the head end. Drawing from Duval's Atlas.

brate embryos. All the organs develop from these three germ layers.

Function of ectoderm. The ectoderm forms the outer covering of the body, the feathers, nails, skin, etc., together with the nervous system and the sense organs.

Function of entoderm. The linings of the digestive tube, the respiratory organs, and the glands associated with them are developed from the entoderm.

Function of the mesoderm. The muscles, the lining of the body cavity, the organs of the circulatory system, the blood, the lymphatic organs, and the urinary system are formed from the mesoderm.

The notochord. As the primitive streak moves backward, an elongated, circular growth of mesoderm, known as the notochord,

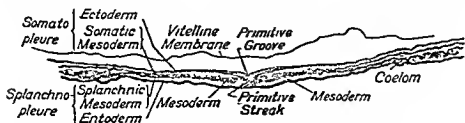


FIG. 212. Cross section through primitive streak. Thirty-six-hour chick.

is left (Figs. 211 and 213). Around this is later formed the bony axis or vertebral column of the body. The notochord itself largely disappears.

The neural groove. A thickening of the ectoderm above the notochord occurs also. It is caused by rapid growth of the cells there, and forms the neural plate. The center of this plate becomes depressed, forming a groove (Figs. 211 and 212). This formation is the first indication of the central nervous system. Later, the groove deepens and the outer edges of it come together, fuse, and separate from the ectoderm, thus leaving it below the surface and above the notochord (Fig. 213).

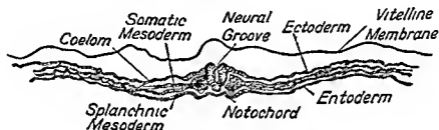


FIG. 213. Cross section ahead of primitive streak. Thirty-six-hour chick.

The head. At 21 to 22 hours of incubation, the front end of the embryo shows a thickened area, raised above the blastoderm. This is the beginning of the head.

The area vasculosa. At 24 hours, the area opaca appears somewhat more dense near the area pellucida (Fig. 220). This is due to the growth of mesoderm, which has reached the point where the blastoderm meets the yolk. The mesoderm collects in clusters, forming blood islands. This is the first step in the formation of blood vessels and corpuscles. The darkened area is the area vasculosa (Figs. 220 and 221).

The somites. On either side of the neural groove, outgrowths of mesoderm appear, developing in pairs. These are called somites (Fig. 211). In all, there are forty-two somites that persist. The first three or four go into the head. Some of those at the extreme rear end of the series of somites degenerate. Nerves develop later for every somite, whether it has degenerated or not.

As the chick develops from the head end toward the rear, some of the older somites begin to be converted into vertebrae before the last somites are formed.

In 95 to 98 per cent of all cases, the embryo lies with the head



FIG. 214. Cross section through primitive streak. Forty-eight-hour chick.

at right angles to the long axis of the egg; i.e., the tail is toward you if the large end of the egg is at your left and the small end at your right (Fig. 221).

Second day of incubation. An interesting feature, illustrating the rapidity of the development of the chick, is the growth of the heart (Figs. 211 and 221). On the second day, growth is so far advanced that on opening an egg into a saucer the heart may be seen to beat. Beating usually starts at about 30 hours.

The embryo continues to elongate, and the neural groove becomes closed over (Fig. 215).

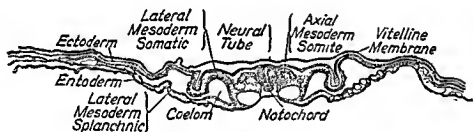


FIG. 215. Cross section ahead of primitive streak. Forty-eight-hour chick.

The walls of the head project, and the formation of the eye is started. The three parts of the brain begin to develop (Fig. 211). The auditory pits, or sensory parts of the ear, may be seen developing from the ectoderm of the head.

The formation of the urinary system is begun *on this day*.

During the second day, the chick's body turns on its left side, and the head end is bent around toward the tail (Figs. 211 and 221). Later development shows the end of the beak and the tail close together.

The fetal membranes. During the early development of the chick embryo, certain fundamental life conditions are necessary. In fact, one of these life conditions, heat, must be present before development will start.

These life essentials are protection, heat, food, water, oxygen, and care of waste products.

With the exception of heat, these essentials are all supplied by growths of the fetal membranes from the inside of the egg and from around the developing embryo. These growths are four in number.

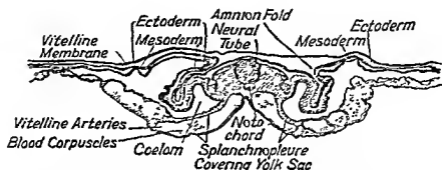


FIG. 216. Cross section through vitelline arteries. Forty-eight-hour chick.

The yolk sac. The yolk sac supplies food and water to the developing embryo. It starts to form when the three germ layers commence to develop. As the germ layers progress outward and downward over the yolk and the embryo grows, other parts develop, forcing the embryo up and the yolk down until a thin stalk extends from the underside of the embryo to the yolk (Figs. 216, 218, and 219). This is the yolk stalk and is the connection between the yolk and the embryo.

The inner layer, or entoderm, and the inner layer of the mesoderm grow down and around the yolk.

The yolk sac and contents are drawn into the body of the chick at about the *nineteenth or twentieth day*. The yolk, thus enclosed, may supply all or part of the food for the chick during 3 days after

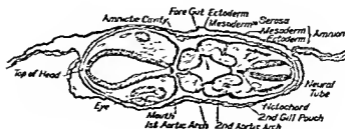


FIG. 217. Cross section through body and head after the head has turned down. Forty-eight-hour chick.

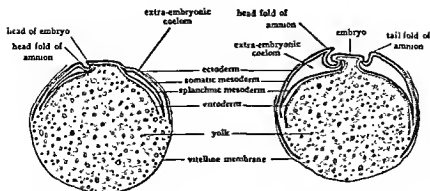


FIG. 218. Schematic diagrams to show the extra-embryonic membranes of the chick. The embryo is cut longitudinally. The albumen, shell membranes, and shell are not shown. *Left*: Embryo early in the second day of incubation. *Right*: Embryo early in the third day of incubation. From Patten's *Embryology of the Chick*.

hatching. In about 6 days after hatching, the yolk and sac are largely absorbed.

The amnion. The amnion gives protection to the developing embryo from the upper side. It starts to grow at about 30 hours and is fully developed at $3\frac{1}{2}$ days.

It is formed from the outer layers of ectoderm and mesoderm (somatopleure) (Fig. 214). The somatopleure starts to bend up and over the embryo (Figs. 216 and 218), finally joining and fusing, above the embryo and separated from it as shown in Fig. 219, left. The amnion is just over the embryo and consists of two germ layers, which are folded over and fused, leaving the mesoderm above and the ectoderm below.

The space between the amnion and the embryo is the amniotic cavity and is filled with a fluid which acts as a protection to the embryo as the egg is moved about.

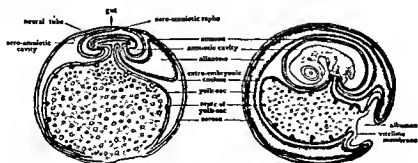


FIG. 219. *Left*: Embryo of five days. *Right*: Embryo of nine days. From Patten's *Embryology of the Chick*.



FIG. 220. The blastoderm at 18 hours of incubation. The shell and shell membrane have been removed just above the blastoderm.

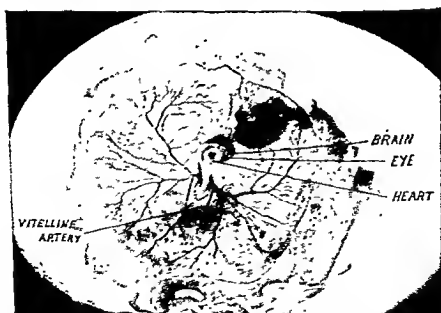


FIG. 221. The embryo at 66 hours of incubation. Note the position of embryo with respect to the position of the egg. Also the well defined outer edge of area vasculosa.

About the *twelfth to sixteenth day* the amniotic cavity receives what is left of the albumen. The embryo swallows amniotic fluid mixed with albumen during this time.*

The serosa. As soon as the amnion is formed, the fusing from either side of the embryo causes the release, or severing, of the layers there, and a new membrane, the serosa, is left around the entire embryo and amnion. In this membrane, the ectoderm is the outer layer and the mesoderm is the inner layer (Figs. 217 and 218). Thus, the folding of the somatopleure has formed two membranes, the amnion and the serosa.

The serosa, with the allantois, carries oxygen to the embryo and carries away the carbon dioxide.

The three membranes remain in communication, in the region of the yolk sac, until late in the development of the embryo.

Third day of incubation. The allantois. Late the third day, the splanchnopleure (Fig. 216), close to the yolk sac and toward the rear of the embryo, forms a hollow bud which grows out rapidly and develops into the allantois (Figs. 219, 222, and 223). As it grows, it becomes filled with a fluid, which distends it. This rapid growth continues until the tenth day and until the allantois takes up the space between the amnion and the serosa.

The outer layer of the allantois is mesoderm. It fuses with the mesoderm of the serosa and becomes filled with blood vessels. The serosa is pressed close to the porous shell, and in this way oxygen is taken in and carbon dioxide given off. The allantois also helps to absorb the albumen of the egg and stores up nongaseous waste matter.

Thus, the four fetal membranes accomplish several of the fundamental life conditions: the yolk sac furnishes food and water, although most of the water is supplied indirectly from the albumen; the amnion provides protection; and the serosa and allantois supply oxygen and remove waste products.

These membranes function only during the incubation period and are absorbed or start to be absorbed before the chick is hatched.

Wings and legs. The wing and leg buds appear during the third day and may be seen at the side and well toward the rear of the embryo (Figs. 222 and 223).

* A. L. Romanoff, "Membrane Growth and Function," *Ann. N.Y. Acad. Sci.*, Vol. 55, p. 293 (1952).

During the *third and fourth days*, there is rapid growth of those internal organs which have already begun to develop. Others, such as the lungs, trachea, esophagus, liver, pancreas, and cloaca, together with the rudimentary sexual organs, start their development at this time.

The development of the embryo during the *fifth day* and thereafter consists in the further growth of buds or organs already

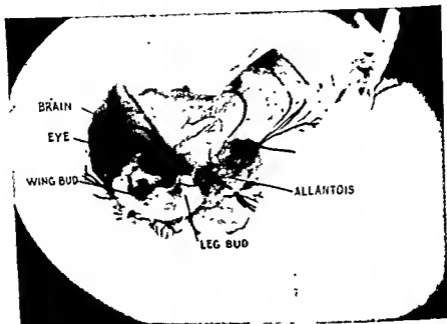


FIG. 222. The embryo at 114 hours of incubation. Note the wing and tail buds and the allantois.

started. By opening two or three eggs each day one can readily observe this growth.

Sixth to tenth day. By this time the mouth opening has taken on the form of the beak, and the slightly roughened surfaces of the body show where the feather tracts will be formed.

On the *sixth day*, the movements of the chick may be seen through the shell.

Daily observations show the growth of wings, legs, toes, nails, feathers, head, and tail. The internal organs, of course, keep pace in their growth with the external parts.

The fluids in the egg gradually evaporate. On the *nineteenth day*, the air cell is very large, occupying approximately one-fifth

to one-quarter of the egg, and the chick fills the remainder of the egg.

Just prior to hatching, the yolk is drawn into the body, and the body wall closes over it. The fetal membranes are cast off. The chick breaks the shell at the large end with its beak, turning in the shell as it breaks. Finally, by pushing and pounding as it gains strength, it forces the top off and thrusts out its head and neck.

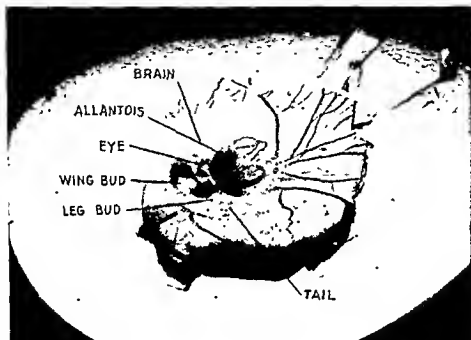


FIG. 223. The embryo at 5½ days of incubation.

When the chick breaks through the shell and secures access to fresh air, the lungs take over the function of blood purification, which until then has been carried on by the serosa and allantois. The period of transition from the embryonic to this final stage is a critical period in the life of the chick. The rapid breathing of the chick during its effort to break through the shell calls for a larger amount of pure air than has been required in the earlier stages. This fact must be taken into consideration in the construction of incubators and their operation at hatching time. In nature, this requirement of the chick is taken care of by the circulation of pure air through the feathers of the hen and by the instinct which leads the newly hatched chick to seek the pure outer air.

Usually, the chick rests for a while and pants from its efforts,

until with a final kick and plunge it is free. As the heat dries the down on its body, it gains strength and in a short time is walking about, a live, downy, alert chick, following its natural instincts of picking for food.



FIG. 224. Embryo about 7 days. The weight of the embryo has caused it to sink into the yolk, making it impossible to see it distinctly. Note the size of the eye.

It has started on its comparatively short, eventful life. Its future achievements are largely in the hands of the poultryman.

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